CALIFORNIA. DEPT. OF WATER RESOURCES
BULLETIN.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING AND IRRIGATION

BULLETIN No. 8

COST OF WATER TO IRRIGATORS IN CALIFORNIA

By

HARRY F. BLANEY, Associate Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.

(Based on data gathered under cooperative agreement between the Bureau of Public Roads of the United States Department of Agriculture, the California State Department of Public Works, and the University of California Agricultural Experiment Station.)

W. F. McCLURE,
State Engineer, and Director of Public Works.

CALIFORNIA STATE PRINTING OFFICE
JOHN E. KING, State Printer
SACRAMENTO, 1925

37104

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING AND IRRIGATION

BULLETIN No. 8

COST OF WATER TO IRRIGATORS IN CALIFORNIA

By

HARRY F. BLANEY, Associate Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.

(Based on data gathered under cooperative agreement between the Bureau of Public Roads of the United States Department of Agriculture, the California State Department of Public Works, and the University of California Agricultural Experiment Station.)

W. F. McCLURE,
State Engineer, and Director of Public Works.

CALIFORNIA STATE PRINTING OFFICE
JOHN E. KING, State Printer
SACRAMENTO, 1925

37104

TABLE OF CONTENTS.

TABLE OF CONTENTS—Continued.

LIST OF TABLES.

LIST OF TABLES—Continued.

COST OF WATER TO IRRIGATORS IN CALIFORNIA.

By Harry F. Blaney, Associate Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.

INTRODUCTION.

This report represents the results of a field study of the cost of water to irrigators under various types of irrigation enterprises in California, which was supported cooperatively by the Bureau of Public Roads, United States Department of Agriculture, the Department of Public Works of California, and the University of California Agricultural Experiment Station. Water yearly is becoming of higher value and more difficult to obtain, in consideration of which bankers, investors, government officials, engineers, and farmers may well ask what expenditure can be justified to develop a water supply on land suitable for growing high grade crops, and what water charge can such land pay. Farmers and prospective farmers are in need of such cost data as will enable them to choose crops that may be grown profitably under existing water charges.

In California the following types of enterprises may furnish irrigation water: public utilities, contract companies, irrigation districts, mutual water companies, individuals, partnerships, associations, private companies, United States Bureau of Reclamation, United States Indian Service, state land settlements, water works districts, municipal improvement districts, and reclamation districts. However, for the purpose of this investigation, most of the data collected may be placed under one of four classifications: public utilities, irrigation districts, mutual water companies, or private pumping plants.

For a report of this character to be useful in published form, it must give information on the type of irrigation system, locality, age, source of water supply, duty of water, acreage irrigated, kind of crops, capital invested, and water charges, in addition to annual cost of water to the irrigator. Such data were obtained for this report by visiting the principal irrigation enterprises of the state. The data on private pumping plants were obtained by making field tests in each case.

Figures on duty of water given in the report are of varying degrees of accuracy. Some are results of careful measurements or metering. At the other extreme are merely the best estimates of the system engineer or superintendent, based on occasional or periodical gaging and close familiarity with the use of water under the system. Great care was taken, however, to have the figures represent, if not exactly, at least approximately, the true use of water, and none have been included that were not considered by the system engineer or superintendent to conform to this standard.

The factors entering into the cost of irrigation water differ for each type of enterprise; hence they will be treated separately under the headings of Public Utilities, Irrigation Districts, Mutual Water Companies, and Private Pumping Plants.

The data have been compiled and summarized in tables, but to many readers the figures would have little meaning without further explana-

tion. Accordingly, each type of enterprise is discussed briefly, with regard to its nature and the factors comprising the annual cost of water; and a description of the compilation accompanies each table.

PUBLIC UTILITIES.

Nature of a public utility—A public utility water company is defined by the state law as follows:

Section 1. Whenever any person, firm or private corporation, their lessees, trustees, receivers or trustees appointed by any court whatsoever owning, controlling, operating or managing any water system within this state, sells, leases, rents or delivers water to any person, firm, private corporation, municipality, or any other political subdivision of the state whatsoever, except as limited by section 2, hereof, whether under contract or otherwise, such person, firm or private corporation is a public utility, and subject to the provisions of the public utilities act of this state and the jurisdiction, control and regulation of the railroad commission of the State of California, *provided, however,* that whenever the owner of a water supply not otherwise dedicated to public use and primarily used for domestic purposes by such owner or for the irrigation of such owner's lands, shall sell or deliver the surplus of such water for domestic purposes or for the irrigation of adjoining lands, or whenever such owner shall, in an emergency water shortage sell or deliver water from such supply to others for a limited period not to exceed one irrigation season, or whenever such owner shall sell or deliver a portion of such water supply as a matter of accommodation to neighbors to whom no other supply of water for domestic or irrigation purposes is equally available then such owner shall not be subject to the jurisdiction, control and regulation of the Railroad Commission of the State of California; *provided, further, however,* that for the purpose of determining the status of any person, firm or private corporation, their lessees, trustees, receivers or trustees appointed by any court whatsoever, owning, controlling, operating or managing any water system or water supply within this state, the railroad commission may hold hearings and issue process and orders in like manner and to the same extent as provided in the public utilities act of the State of California and the findings and conclusions of the railroad commission on questions of fact arising under this act shall be final and not subject to review, except as provided in said public utilities act.

Sec. 2. Whenever any private corporation or association is organized for the purpose solely of delivering water to its stockholders or members at cost, and delivers water to no one except its stockholders or members at cost, such private corporation or association is not a public utility, and is not subject to the jurisdiction, control or regulation of the railroad commission of the State of California.*

Contract water companies selling water to non-contract holders have been classified by the commission as public utilities to that extent, as have mutual water companies delivering water for compensation to others than their members or stockholders.

Method of financing—Most public utility water companies have been financed by private capital. Theoretically the capital stock represents the investment, or the cost of water rights, developing a water supply, and irrigation works.

The original irrigation enterprises of this type were generally of two classes: those under which water rights were sold for a fixed sum, with the addition of an annual charge for maintenance and operation of the irrigation system, and those under which water was furnished for an annual rental.

Under the Public Utilities Act of 1911 the State Railroad Commission was given the power not only to fix the rates charged by water corporations, but practically to regulate their entire business, including manner of service, measurement of water, incurrence of indebtedness, accounting,

*Statutes 1913, Chapter 80 and Statutes 1923, Chapter 172.

profits, etc. Each company is required to file its rates with the commission and to give a yearly report, on special forms provided, showing details of their operations.

FACTORS IN COST OF WATER UNDER PUBLIC UTILITIES.

The factors that determine the annual cost of water to irrigators under public utilities are water rates and duty of water.

Water rates—Under the public utilities the water rate represents the entire cost to the user and the interest on investment is a matter of concern for the corporation only. Rates established by the California Railroad Commission allow a reasonable profit to the utilities on the investment, if practicable. In fixing rates the commission considers three items of expense: "Interest on the investment," "depreciation," and "maintenance and operation."

Eight per cent interest is the maximum allowed on invested capital, which is determined by an appraisal of physical property on original cost basis. The company's records of cost are not depended upon unless they are complete and accurate. In some cases full cash was not paid in for stock, and money to build the plant came from sale of bonds. If the company is paying interest on bonds, then that interest must come out of the allowance for return on investment, but if interest on the bonds is less than this amount the stockholder gets part of the profit and the bond holder gets part only. There is no profit over that set by the commission allowed, but this is liberal considering that the utility, under regulation by the state, is assured of that return.

The amount of investment having been determined, depreciation is computed. Generally this is done by the sinking fund method. The maintenance and operation expenses are generally not hard to determine, as under the law the companies keep fairly accurate records of these items.

Public utility water rates are not uniform in their units of measurements. About 50 per cent of the companies use the flat rate per year—either so much per acre per year or a fixed amount per miner's inch per year. In many cases the acre unit is used, no doubt because when the original rates were established water was so cheap and plentiful that companies did not feel justified in making the expenditures necessary to measure it. Obviously under this system an irrigator will pay just as much per acre whether he uses one acre foot or four acre feet, and there is no incentive to conserve water. A few companies have endeavored to make the flat rate more uniform by varying the rate per acre, depending upon the crops grown.

Other units used are the acre-foot, cubic foot, cubic foot per second for 24 hours, per irrigation, miner's inch per hour, and miner's inch per 24 hours. The value of the miner's inch also varies, in most cases being equal to either 1.50 second-foot or 1.40 second-foot.

Duty of water—The amount of water used by the irrigator is a factor in computing the annual cost of water per acre-foot when the flat rate is used. It is also a factor in determining the annual cost per acre when the rate is based on some unit of measurement.

The data given on duty of water represent the average amount of water delivered to the irrigator; that is, the amount of water paid for. This may be considered in most cases the net duty of water for the system.

COST OF WATER UNDER PUBLIC UTILITIES.

Description of Table 1—Table 1 has been prepared to show annual cost of water to irrigators under public utilities, the data being grouped as representing northern, central and southern California. In addition to the cost of water to irrigators, factors which affect the cost of water and other useful facts are shown in the table. Most of the column headings are self explanatory; hence only a few of them will be described in detail here.

Column 4, "Year organized" may or may not indicate the age of the water rights, as some companies have reorganized or bought out early rights to water.

Column 17, "Water charges per acre-foot" is a reduction of column 16, "Rate" to an acre-foot basis in such cases as permit the reduction.

Column 18 shows the water charges "Per acre for average amount used." If the water charge is a flat rate per acre, column 18 equals column 16, otherwise column 18 is the product of column 17 and column 15.

Column 19 gives "Cost of water per acre for the first acre-foot" and is equal to figures in column 18 if a flat rate per acre is used; otherwise it is equal to column 17.

Column 20 shows the "Cost of water per acre for the average amount used." It is equal to column 18.

Column 21, "Cost per acre-foot for the average amount used," is obtained by dividing column 20 by the duty of water shown in column 15.

Columns 19, 20 and 21 indicate the cost of water, including the interest on capital invested. Public utility water rates include interest on capital invested and represent the entire charge to the user. It was deemed impracticable to estimate the interest as it would require a comprehensive study of each case.

While the figures in Table 1 represent the cost of water to irrigators they may not in some cases indicate what it actually costs the companies to deliver the water, mainly because some companies have had rate hearing before the state railroad commission and have been allowed 8 per cent interest on their investment, while other companies which perhaps did not care to antagonize the farmers have never had their rates before the commission and in some instances are not making interest on capital invested. Table 1 is condensed in the following tables:

Duty of water—Table 2 is a summary of column 15 of Table 1 showing the minimum and maximum duty of water under public utilities in northern, central and southern California and for the state as a whole. The number of companies considered is also shown.

TABLE 2—SUMMARY OF DUTY OF WATER UNDER PUBLIC UTILITIES.

Section of California	Number of companies considered	Quantity of water used, per acre	
		Minimum, acre-feet	Maximum, acre-feet
Northern	13	1 00	6 00
Central	24	1 00	6.52
Southern	9	1 00	3 00
Entire state	46	1 00	6.52

TABLE I. COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Public Utilities in Northern, Central and Southern California. 1922[1]

1	2	3	4	5	6	7	Area irrigated							15	Factors in annual cost of water			Annual cost of water including interest on capital invested		
															Water charges					
Name of company	Address	County	Year organized	Source of water supply	Percentage of water pumped	Lift, feet	8 Citrus trees, acres	9 Deciduous trees and vines, acres	10 Alfalfa, acres	11 Grain, acres	12 Rice, acres	13 Miscellaneous, acres	14 Total, acres	Average duty of water per acre at delivery gate, acre-feet	16 Rate	17 Per acre-foot	18 Per acre for average amount used	19 Per acre for first acre-foot	20 Per acre for average amount used	21 Per acre-foot for average amount used
NORTHERN CALIFORNIA.																				
Coneland Water Co.[2]	Los Molinos	Tehama	1907	Mill and Antelope Creeks	0	0		x	x			x	10,000	3.30	$3 50 per acre (2-5 [3]M.I. per mo.)		$3 50	[4]$2 00	$3 50	$1 06
Cottonwood Irrigation and Mining Co.	Horubrook	Siskiyou	1904	Cottonwood Creek	0	0							500	1 60	0 10 per [3]M.I. per 24 hours		3 23	2 02	3 23	2 02
El Dorado Water Corporation	Placerville	El Dorado	1919	American River, Webber Creek	0	0		4,800				200	5,000	1 14	30 00 per [3]M.I. per season		[5]6 00	6 00	6 00	5 26
Excelsior Water and Power Co.	Smartsville	Yuba and Nevada		Yuba River and Deer Creek	0	0		x	x			x	2,700	1.23	0 25 per [3]M.I. per 24 hours	5 04	6 20	5 04	6 20	5 04
Natomas Water Co.	Sacramento	Sac'to and El Dorado		American River	0	0	[1]300	1,383					1,683	3.40	5 00 per acre		5 00	5 00	5 00	1 47
North Fork Ditch Co.	Sacramento	Placer	1899	American River	0	0	x	x				x	1,900	1 70	35 00 per [3]M.I. per year		[6]7 00	7 00	7 00	4 12
Pacific Gas and Electric Co.	Auburn	Placer	1905	South Yuba River	0	0		26,400					26,400	1.36	45 00 per [3]M.I. per year		[6]8 18	8 18	8 18	6 01
Pacific Gas and Electric Co.	Nevada City	Nevada	1905	South Yuba River	0	0		350					350	2 37	0 16 per [3]M.I. per 24 hours	3 23	7 66	3 23	7 66	3 23
Pacific Gas and Electric Co.	Oroville	Butte	1905	Feather River	0	0	x	x				x	1,500	2 75	0 10 per [3]M.I. per 24 hours	2 02	5 56	2 02	5 56	2 02
Palermo Land and Water Co.[2]	Palermo	Butte		Feather River	0	0	x	x					2,065	1 33	0 22 per [3]M.I. per 24 hours	5 55	7 38	5 55	7 38	5 55
South Feather Land and Water Co.[2]	Oroville	Butte and Yuba	1908	Lost Creek	0	0	x	x					1,800	[2]2 00	60 00 per [3]M.I. per season		[1]12 00	12 00	12 00	6 00
Sutter Butte Canal Co.	Gridley	Butte and Sutter	1912	Feather River	5	27		4,741	2,814	2,618	28,037	18,568	56,778	2.50	2 30 per acre for most crops			2 30	2 30	0 92
															[6]6 00		7 80		7 80	1 30
Yolo Water and Power Co.	Woodland	Yolo	1911	Cache Creek	0	0		2,104	9,333	523	9,419	2,085	23,464	1 00	3 00 per cu. ft. per 24 hrs.—trees	1 51	1 51	1 51	1 51	1 51
														2.00	3 00 per cu. ft. per 24 hrs.—Alfalfa	1 51	3 02	1 51	3 02	1 51
														5.95	3 00 per cu. ft. per 24 hrs.—rice	1 51	8 98	1 51	8 98	1 51
CENTRAL CALIFORNIA.																				
Consolidated Canal Co.[6]	Fresno	Fresno	1901	Kings River	0	0		x	x			x	100,400	2.10	0 75 per acre + 0.36 C.I.D. tax		1 11	1 11	1 11	0 53
Eastside Canal and Irrigation Co.	Newman	Merced	1887	San Joaquin River	0	0			x	x			6,500	[2]2 00	2 34 per acre (average)		2 34	2 34	2 34	1 17
Empire Water Co.[2]	Lemoore	Kings	1906	Kings River	0	0		x	x	x			[1]16,000	[2]2 00	1 00 per acre		1 00	1 00	1 00	0 50
Foothill Ditch Co.		Tulare						x		Field crops			1,800	[2]2 00	0 14 per [3]M.I. per 24 hrs.	2 82	5 64	2 82	5 64	2 82
Kern County Canal and Water Co.	Bakersfield	Kern		Kern River																
Anderson Canal Co.	Bakersfield	Kern	1878	Kern River	0	0			x	x		x	[2]2,400	3 82	1 50 per acre		1 50	1 50	1 50	0 39
Buena Vista Canal Co.	Bakersfield	Kern	1878	Kern River	0	0		125	3,281	1,964		3,409	8,779	1 47	0 75 per cu. ft. per sec.—24 hrs.	0 38	0 56	0 38	0 56	0 38
Central Canal Co. (Calloway)	Bakersfield	Kern	1891	Kern River	0	0		856	13,115	5,378		3,747	23,096	2 37	0 75 per cu. ft. per sec.—24 hrs.	0 38	0 90	0 38	0 90	0 38
				Kern River	0	0			6,760	980		3,080	10,820	[2]2 50	1 50 per acre		1 50	1 50	1 50	0 60
East Side Canal Co.	Bakersfield	Kern	1892	Kern River	0	0		708	2,455	2,407		181	5,750	3.06	0 75 per cu. ft. per sec.—24 hrs.	0 38	1 16	0 38	1 16	0 38
Farmer Canal Co.	Bakersfield	Kern	1880	Kern River	0	0		30	1,340	580		803	2,753	2 35	0 75 per cu. ft. per sec.—24 hrs.	0 38	0 89	0 38	0 89	0 38
Gates Canal Co.	Bakersfield	Kern		Kern River	0	0							[1]300	[3]3 00	0 75 per cu. ft. per sec.—24 hrs.	0 38	1 14	0 38	1 14	0 38
James Canal Co.	Bakersfield	Kern	1878	Kern River	0	0			x	x		x	[1]6,800	3 82	1 50 per acre		1 50	1 50	1 50	0 39
Kern Island Canal Co.	Bakersfield	Kern	1870	Kern River	0	0		x	x	x		x	35,015	1 99	0 75 per cu. ft. per sec. for 24 hrs.	0 38	0 76	0 38	0 76	0 38
Kern River Canal and Irrigation Co.	Bakersfield	Kern	1892	Kern River	0	0		550	3,720	1,324		311	5,905	5.06	0 60 per cu. ft. per sec. for 24 hrs.	0 30	1 52	0 30	1 52	0 30
Lerdo Canal Co.	Bakersfield	Kern	1892	Kern River	0	0		535	1,445	404			2,384	6 52	0 75 per cu. ft. per sec. for 24 hrs.	0 38	2 48	0 38	2 48	0 38
Pioneer Canal Co.	Bakersfield	Kern	1878	Kern River	0	0		10	2,550	1,235		5,140	8,935	2 70	0 75 per cu. ft. per sec. for 24 hrs.	0 38	1 03	0 38	1 03	0 38
Plunkett Canal Co.	Bakersfield	Kern	1878	Kern River	0	0			x	x		x	[1]1,000	[3]3 00	1 50 per acre		1 50	1 50	1 50	0 50
Stine Canal Co.	Bakersfield	Kern	1878	Kern River	0	0		90	3,700	1,641		669	6,100	3 25	0 75 per cu. ft. per sec. for 24 hrs.	0 38	1 24	0 38	1 24	0 38
Kings County Canal Co.	Los Angeles	Tulare and Kings	1905	Floodwater Tule River	0	0							1,203	[1]1 00	1 00 per acre		1 00	1 00	1 00	1 00
Madera Canal and Irrigation Co.	Madera	Madera	1888	Fresno and Merced Rivers	0	0		[4]4,900	[6]6,100			x	12,202	1 67	0 50 to 1.25 per ac.-ft. ($1.00 average)	1 00	1 67	1 00	1 67	1 00
Monterey County Water Co.	Spreckels	Monterey	1901	Arroyo Seco River	0	0			1,200			900	2,100	1 50	1 50 per irrigation (2 irrig.)		3 00		3 00	2 00
Pacific Gas and Electric Co.	Sonora	Tuolumne	1905	Stanislaus River	0	0		2,200					2,200	1 29	0 21 per [3]M.I. per 24 hrs.	4 24	5 47	4 24	5 47	4 24
San Benito County Water Co.	Hollister	San Benito	1908	San Benito River	0	0		1,000					1,000	1 50	5 00 per acre for 2 irrigations		5 00	5 00	5 00	3 33
San Joaquin and Kings River Canal and Irrigation Co.	Los Banos	Merced	1905	San Joaquin and Kings Rivers	0	0			[7]2,000			[7]7,877	79,877	[2]2 20	1 75 per acre in Merced County		1 75	1 75	1 75	0 80
San Joaquin and Kings River Canal and Irrigation Co.	Los Banos	Fresno	1905	San Joaquin and Kings Rivers	0	0								[2]2 20	1 25 per acre in Fresno County		1 25	1 25	1 25	0 57
San Joaquin and Kings River Canal and Irrigation Co.	Los Banos	Stanislaus	1905	San Joaquin and Kings Rivers	0	0								[2]2 20	2 25 per acre in Stanislaus County		2 25	2 25	2 25	1 02
SOUTHERN CALIFORNIA.																				
Appleton Land, Water and Power Co.	Hesperia	San Bernardino	1911	Deep Creek	0	0			90	120			210	[1]1 50	0 015 per [3]M.I. per hour	9 08	13 62	9 08	13 62	9 08
Bell Water Co.	Bell	Los Angeles	1902	Wells	100								65	1 31	2 00 per 100 [3]M.I. per hour	12 10	15 85	12 10	15 85	12 10
California Michigan Land and Water Co.	Los Angeles	Los Angeles		Wells	100								[1]700	[1]1.00	0 04 and 0.20 per 100 cu. ft.	20 62	20 62	20 62	20 62	20 62
Cuyamaca Water Co.	San Diego	San Diego	1913	Boulder and San Diego Rivers	0	0	x	x	x			x	4,000	[1]1.00	0 06 per 100 cu. ft. (average)	25 14	25 14	25 14	25 14	25 14
Farmers Ditch Co.	Santa Paula	Ventura	1917	Santa Clara River	0	0	x	x	x			x	4,200	1.52	0 20 per [3]M.I. per 24 hrs. (majority)	5 04	7 66	5 04	7 66	5 04
									x					3.00	0 10 per [3]M.I. per 24 hrs. (alfalfa)	2 52	7 56	2 52	7 56	2 52
Lake Hemet Water Co.[8]	Hemet	Riverside	1887	Lake Hemet	0	0	x	x	x			x	7,000	1 00	0 40 per [3]M.I. per 24 hrs.	10 10	10 10	10 10	10 10	10 10
San Gabriel Valley Water Co.	Los Angeles	Los Angeles	1908	Wells	100		200					x	[1]700	1 50	0 50 per 1000 cu. ft.	21 78	32 67	21 78	32 67	21 78
Santa Clara Water and Irrigation Co.	Saticoy	Ventura	1871	Santa Clara River	0	0	x	x	x			x	2,250	1 50	0 20 per [3]M.I. per 24 hrs. (beans and orchard)	5 04	7 56	5 04	7 56	5 04
									x					[3]3 00	0 04 to 0.10 per [3]M.I. per 24 hrs. (alfalfa)		5 54	2 52	5 54	1 85
Sweetwater Water Co.	National City	San Diego	1902	Sweetwater Reservoir	0	0	2,313	299	236			1,552	4,400	1 00	0 05 per 100 cu. ft.	21 78	21 78	21 78	21 78	21 78

REMARKS.—[1] Estimated. [2] Rate for 1-5 M.I. per month. [3] 1 M.I. to 5 acres, basis. [4] 1 M.I. to 5.5. acres, basis. [5] Contract company. [6] Taken over by Irrigation District. [7] 40 miner's inches=1 sec.-ft. [8] 50 miner's inches=1 sec.-ft. [9] 46 miner's inches=1 sec.-ft. M.I., abbreviation for miner's inch. x Acreage unknown.

PLATE I.

FIG. 1. Dam across Sacramento River at head of Anderson-Cottonwood Irrigation District.

FIG. 2. A concrete-lined irrigation canal on the Orland Project of the United States Reclamation Bureau.

Descriptio
of water to
representing
to the cost
and other
headings ar
in detail he

Column
water right
rights to wa

Column
16, "Rate"

Column
used." If t
16, otherwi

Column
is equal to
it is equal t

Column
used." It i

Column
obtained by
15.

Columns
on capital i
invested ar
impracticab
study of ea

While th
they may
panies to d
rate hearing
8 per cent
perhaps di
rates befor
interest on
tables:

Duty of w
the minim
northern, c
The numbe

TAB

Northern
Central
Southern
Entire state

PLATE I.

FIG. 1. Dam across Sacramento River at head of Anderson-Cottonwood Irrigation District.

FIG. 2. A concrete-lined irrigation canal on the Orland Project of the United States Reclamation Bureau.

In Table 2 the high duty of 1.00 acre-foot per acre is found under systems which grow either fruits or grains that require little water, or which are short of water. It is interesting to note that of the systems having such a high duty, the lowest cost per acre-foot is $1.00 per acre-foot while the highest is $25.14. Both companies referred to furnish gravity water only, but the one having the low rate depends mainly on flood waters, while that having the highest rate has expensive storage works.

The low duty of 6.52 acre-feet per acre is not representative, as the system suffers high seepage losses. The 6 acre-feet per acre duty, shown for a project where rice is grown, is a value better representing the lowest duty.

Annual cost of irrigation water—Table 3 is a summary of columns 20 and 21 in Table 1, showing the minimum and maximum cost of water under public utilities in northern, central and southern California, and for the state as a whole. The number of companies considered is also shown.

TABLE 3—SUMMARY OF THE ANNUAL COST OF WATER UNDER PUBLIC UTILITIES.

Section of California	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	13	$1 51	$12 00	$0 92	$6 01
Central	24	56	5 64	30	4 24
Southern	9	5 54	32 67	1 85	25 14
Entire state	46	56	32 67	30	25 14

Practically all the water used under the public utilities in northern California is gravity with some storage. In central California where the cheapest water is found it is all gravity with very little storage. In southern California the high rates are due either to expensive storage works for gravity water, cost of pumping water, or costly distribution systems on account of scarcity of water.

Cost of water for various crops—It is difficult to make very accurate comparisons of the cost of irrigation water according to crops grown, because most systems furnish water to more than one kind of crop and very few keep records that would make this possible. However, the following summaries of columns 20 and 21, Table 1, give some indication of the variations in costs for citrus trees, deciduous trees and vines, alfalfa and rice, in northern, central and southern California and the state as a whole. The number of companies considered is shown in each table.

TABLE 4—SUMMARY OF ANNUAL COST OF WATER UNDER PUBLIC UTILITIES IN NORTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	5	$5 00	$12 00	$1 47	$6 00
Deciduous trees and vines	12	1 51	12 00	92	6 01
Alfalfa	4	2 30	6 20	92	5 04
Rice	2	7 80	8 98	1 30	1 51

TABLE 5—SUMMARY OF ANNUAL COST OF WATER UNDER PUBLIC UTILITIES IN CENTRAL CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	None				
Deciduous trees and vines	15	$0 56	$5 64	$0 30	$4 24
Alfalfa	19	56	3 00	30	2 00
Rice	None				

TABLE 6—SUMMARY OF ANNUAL COST OF WATER UNDER PUBLIC UTILITIES IN SOUTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	7	$7 56	$32 67	$5 04	$25 14
Deciduous trees and vines	7	7 56	25 14	5 04	25 14
Alfalfa	6	5 54	25 14	1 85	25 14
Rice	None				

TABLE 7—SUMMARY OF ANNUAL COST OF WATER UNDER PUBLIC UTILITIES IN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	12	$5 00	$32 67	$1 47	$25 14
Deciduous trees and vines	34	56	25 14	30	25 14
Alfalfa	29	56	25 14	30	25 14
Rice	2	7 80	8 98	1 30	1 51

The figures in tables 4, 5, 6 and 7, indicate clearly that the cost of irrigation water is a potent influence in determining the kind of crops that can be grown profitably. The highest costs per acre-foot are found where citrus trees are irrigated; then follow deciduous trees and vines,

alfalfa, and rice. The high cost per acre for rice is due to the large amount of water used. However, the average cost per acre-foot for rice is less than the cost for any of the other crops shown.

IRRIGATION DISTRICTS.

Nature of Irrigation Districts—The irrigation district* may be defined as a public corporation organized under state laws empowering it to issue bonds and levy and collect taxes, with the object of providing funds for a water supply to irrigate lands within its boundaries, and for the operation and maintenance of its irrigation system. California irrigation districts are political subdivisions of the state and are organized under the jurisdiction of the county in which they are located. The affairs of a district are administered by a board of directors, assessor, tax collector, treasurer and secretary, all of whom are elected except the secretary who is appointed.

Method of financing—Districts issue bonds to provide funds for obtaining a water supply and distribution system to irrigate land within their boundaries. Taxes are levied to raise funds to retire these bonds when they fall due, for interest on the bonds, the cost of operation and maintenance of the system, and all other general expenses. Some districts have a water toll or charge to cover the cost of operation and maintenance.

Bonds.

Irrigation district bonds are legal investments for savings banks, trust companies, trust funds, and insurance companies, when approved by the state irrigation district bond commission. In certifying the bonds the commission limits the bonded indebtedness to 60 per cent of the market value of the irrigation system and the land within the district. These bonds are exempt from personal property tax in California.

Assessments.

The district assessment roll is prepared and equalized by the irrigation district officials, who likewise attend to levying and collecting the taxes. Improvements are not assessed. The assessed valuation does not include the value of the irrigation system. Values shown in the assessment roll are for the land alone.

The method of fixing valuations per acre for assessment purposes varies. Some districts assess all the land on a flat rate per acre. Other districts base their valuations on the character of the land, such as irrigable by gravity, irrigable by pumping, alkalized swamp, river bottom, hillside, town lots, or non-irrigable lands. Districts have set one valuation on lands served by system and another for lands not reached by the present ditches. In some cases districts vary assessed valuations according to distances from town centers.

The assessments are generally paid in two installments, the first being delinquent on the last Monday in December and the second delinquent on the last Monday in June. These taxes if unpaid become a lien on the land.

"The rate of assessments levied is ascertained by deducting 15 per cent for anticipated delinquencies from the aggregate assessed value of the

* *For detailed information on irrigation districts, see Bulletin 7, "California Irrigation Districts' Laws;" California State Department of Public Works, Division of Engineering and Irrigation.

property in the district as it appears on the assessment roll for the current year, and then dividing the sum to be raised by the remainder of such aggregate assessed value."*

Special assessments may be made if the majority of votes cast at a special election favor them.

FACTORS IN COST OF WATER UNDER IRRIGATION DISTRICTS.

The main factors determining the annual cost of water to irrigators, under an irrigation district, are district tax, water tolls, duty of water, and interest on capital invested.

District tax—The district tax may be segregated into bond interest, bond principal, rentals due, permanent improvements, cost of power, maintenance and operation, administration and general purposes. However, most districts limit their segregation to bond interest, bond principal, and general fund. Hence it is hard to determine from the tax rate just what portion of the general fund is used for permanent construction, for maintenance and operation, or general purposes.

In order to ascertain that portion of the tax which goes toward annual cost, the tax for bond principal and permanent improvements should be subtracted from the total tax and charged to capital account. In other words, that portion of the tax to be charged to annual cost includes interest on bonds, maintenance and operation, and other general expenses.

In reducing the district tax from the rate per one hundred dollars assessed valuation to a rate per acre, the usual assessed valuation per acre for irrigable lands was used. This was taken instead of the average assessed valuation per acre, the latter, in some cases, being too low because of low valuation of non-irrigable land, or too high because of high valuation of lands in towns.

In computing the tax per acre, an average of the 1921-1922 and 1922-1923 assessments was used rather than those for a single year, because some of the district expenses may overlap from one assessment year to the other. The fiscal years used by the districts are not uniform and few districts keep their records on the basis of the calendar year. Generally assessments levied in one year are to cover estimated expenses for the following year. The assessments so made are collected in most districts in two installments, the first in December of the year made and the second in June of the following year. For this reason some authorities would consider the 1922-1923 assessment to represent the cost for the year 1923, while others would consider the average of the 1921-1922 and 1922-1923 assessments as representing the cost of the calendar year 1922.

Water tolls—Some irrigation districts secure their funds for operation and maintenance purposes from water tolls, using various units to determine the water charge. Many districts feel that the cost of installing measuring devices and of measuring the amount of water used by each irrigator is prohibitive, hence their water toll is based on a flat rate per acre. In a few instances the flat rate varies according to the crop grown or to whether the water is gravity or pumped. Other districts charge by the acre foot, hour-inch, or cubic foot, depending upon their kind of measuring devices.

*Section 60 of California Irrigation District Act.

These unit charges may also vary according to amount of water used. A few districts assess their tolls on the basis of an irrigation, the rate varying with the crops grown or the method of irrigating. In the tabulations that are to follow all water tolls have been reduced to an acre basis.

Duty of water—The amount of water used is a factor entering into the annual cost of water when it is desired to ascertain this cost on the acre or acre-foot basis. The duty of water figures given in this report represent the average amount of water delivered to the irrigator. In other words, it is the amount of water he pays for. Generally speaking it may be considered the net duty of the system.

Interest on capital invested—The capital invested by the land owners, in the irrigation system of a district, may be divided into two parts: First, the total amount of capital raised for permanent improvements by assessment since the district was organized. These figures are available only for a few districts, and will be disregarded here as far as interest on capital invested is concerned. Second, the total amount of bonds retired by the districts. Only a small percentage of the districts have retired bonds, which in many cases are long-termed.

For these reasons the interest on capital invested by the landowners is a small factor in determining the final cost of water to the irrigator. However, it is a large factor in some of the other types of enterprises, hence it will be shown wherever possible.

COST OF WATER UNDER IRRIGATION DISTRICTS.

Description of Table 8—Table 8 has been prepared to show the annual cost of water to irrigators under many of the principal irrigation districts operating in the state in 1922.

The data have been grouped as representing northern, central, and southern California. The tabulations comprise 33 columns. In addition to the cost of water to irrigators, factors affecting the cost of water and many other pertinent elements are shown in the table. Most of the headings are self explanatory, and will not be referred to further.

Column 4, "Year organized" does not necessarily give the age of the system or water rights, because the district may have been organized to take over an existing system or water right.

Column 6, "Estimated irrigable area" makes allowance for roads, canals, towns, and other non-irrigable lands.

Column 17 shows "Average duty of water at delivery gate" in acre-feet, and in many cases represents the net duty of water for the system.

Column 18, "Total authorized bonded debt per acre" is obtained by dividing the total amount authorized bonded debt by the acreage in the district. Column 19, "Total present bonded debt per acre" is the result of dividing the total amount of present bonded indebtedness by the acreage in the district. Column 20, "Total bonded debt retired per acre" is obtained by dividing the total amount of bonded debt retired, by the acreage in the district.

Column 21, "Usual assessed valuation per acre" is for the 1922-1923 tax levy.

Column 22, "Interest on retired bonds per acre at 6 per cent" is computed from figures shown in column 20.

Column 23, "Average district tax per acre for the past 2 years" is obtained by reducing the tax rate per hundred dollars for 1921-1922

TABLE 8. COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Irrigation Districts in Northern, Central, and Southern California. 1922.

1 Name of district	2 Address	3 County	4 Year organized	5 Area in district, acres	6 Estimated irrigable area, acres	7 Source of water supply	8 Percentage of water pumped	9 Lift, feet	Area irrigated: 10 Citrus trees, acres	11 Deciduous trees and vines, acres	12 Alfalfa, acres	13 Grain, acres	14 Rice, acres	15 Miscellaneous, acres	16 Total, acres	17 Average duty of water at delivery gate, acre-feet	18 Total authorized bonded debt per acre	19 Bonded debt per acre (January 1, 1923)	20 Total bonded debt retired per acre	21 Usual district assessed valuation per acre for 1922-23	Factors in annual cost of water: 22 Interest on retired bonds per acre at 6 per cent	23 Average district tax per acre for last two years	Water tolls: 24 Kind of crops	25 Rate	26 Per acre-foot	27 Per acre for average amount used	Deductions, average past two years: 28 Bond principal tax per acre	29 Permanent improvement tax per acre	Annual cost of water: Per acre for average amount used: 30 Excluding interest on retired bonds	31 Including interest on retired bonds	Per acre-foot for average amount used: 32 Excluding interest on retired bonds	33 Including interest on retired bonds
NORTHERN CALIFORNIA																																	
Anderson-Cottonwood	Anderson	Shasta	1914	31,400	23,349	Sacramento River	9	12		847	2,279				x	5,283	4 00	$39 95	$37 15	$0 00	$60 00	$0 00	$5 10		None			$0 00	$0 00	$5 10		$1 28	
Carmichael	Sacramento	Sacramento	1916	3,100	3,000	American River	100	55	x	Maximum						1,800	4 50	20 03	28 45	58	80 00	03	5 50		$2.50 per acre	$2 50	29	0	7 71	$7 74	5 11	$5 16	
Citrus Heights	Fair Oaks	Sacramento	1920	3,028	3,000	North Fork Ditch Co	0		150	1,050						1,200	1 70	86 53	65 45	0	60 00	0	6 00		4.00 per acre		3 00	0	0	9 60		5 64	
Cordua	Marysville	Yuba	1919	5,512	5 412	Yuba River	0			x	x	x	Maximum	x		1,660	3 00	48 14	46 63	0	120 00	0	4 70		None			0	0	4 70		7 78	
Fair Oaks	Fair Oaks	Sacramento	1917	4,000	3,200	North Fork Ditch Co	0		1,600	600						2,200	2 40	50 00	40 00	0	80 00	0	3 40		$4.00 per acre		5 00	0	0	9 40		3 92	
Glenn-Colusa	Willows	Glenn, Colusa	1920	105,000	84,000	Sacramento River	94	5 8	x	x	x			31,500	x	42,000	6 90	24 64	21 63	1 27	50 00	08	2 56	Rice	65 per acre-ft	$0 65	4 62	58	0	6 60	6 68	96	97
Glenn-Colusa	Willows	Glenn, Colusa															3 00					08	2 56	General	75 per acre (for 1st 2 ½ -ft.)		1 42	58	0	3 10	3 18	1 13	1 16
Grenada	Grenada	Siskiyou	1921	5,080	4,064	Shasta River	100	64			2,400					2,400	2 00	47 21	47 24	0	200 00	0	12 00		None on 1922			0	0	12 00		6 00	
Happy Valley	Olinda	Shasta	1891	18,277	13,213	Creeks	0			2,000					200	2,200	0 50	41 86	40 49	0	80 00	0	1 00		None			0	0	9 00		18 00	
Jacinto	Glenn	Glenn	1916	11,468	11,200	Sacramento River	84	5 8	40	349	767	60			1,196	2,412	2 25	20 77	20 33	41	60 00	03	2 85	General	$1.00 per acre		1 00	57	0	5 28	3 31	1 46	1 47
Paradise	Paradise	Butte	1916	11,250	8,500	Little Butte Creek	0			1,510					1,000	2,400	1 00	43 56	43 56	0	90 00	0	5 40		None			0	0	5 40		5 40	
Princeton-Codora-Glenn	Princeton	Glenn, Colusa	1916	13,861	11,580	Sacramento River	100			2,000	x	x	1,800	x	5,400	6 00	12 63	12 63	0	67 50	0	1 33	Rice	$8.00 per acre		8 00	0	0	9 43		1 56	
Princeton-Codora-Glenn	Princeton	Glenn, Colusa				Sacramento River											2 00					0	1 33	General	2.75 per acre		2 75	0	0	4 08		2 04	
Reclamation District No 108		Colusa		58,000	50,700	Sacramento River	70	5					1,110			1,110	9 00							Rice	3.37 per acre		3 37			3 37		37	
CENTRAL CALIFORNIA																																	
Alpaugh	Alpaugh	Tulare	1915	8,068	8,068	21 wells	100	55		225	1,575	2,600				4,400	2 00	35 07	35 07	0	50 00	0	3 50					0	51	7 81		3 91	
Alta	Dinuba	Tulare, Fresno	1888	140,000	136,000	Kings River	0		900	64,100	x	3,000			x	100,000	1 50	3 84	3 15	63	45 00	03	1 15		$0.80 per hr. 200 head	2 42	4 84	0	10	15 00	9 94	60	63
Byron-Bethany	Byron	Contra Costa	1919	17,600	11,333	Old River (San Joaquin)	100	45 to 155			6,000					6,000	1 57	31 25	31 25	0	130 00	0	5 85		$2.50 per acre-foot	2 50	4 94	0	0	9 78		6 23	
Consolidated	Selma	Fresno, Tulare, Kings	1921	150,000	150,000	Kings River	0			Maximum	x	x			x	125,000	2 10	5 67	5 67	0	100 00	0	7 36		.75 per acre		75	0	0	1 11		53	
Corcoran	Corcoran	King	1919	51,570		Kings River	0				x	x			x	16,000	3 26	14 71	14 71	0	100 00	0	3 40		.50 and $1.00 per irrigation		2 00	0	0	3 40		1 04	
Fresno	Fresno	Fresno	1920	213,000	213,000	Kings River	0			104,000					x	215,000	1 84	8 23	8 23	0	100 00	0	1 27		None			0	0	1 27		0 69	
James	San Joaquin	Fresno	1920	26,500	20,000	Kings River and wells	30	35			x	x				10,000	2 00	37 73	37 73	0	150 00	0	4 15		$2.00 per acre gravity		2 00	0	0	9 15		3 48	
James	San Joaquin	Fresno																				0	4 15		3.50 per acre (pumped)		3 50	0	0	7 65		4 83	
Lindsay-Strathmore	Lindsay	Tulare	1915	15,289	14,500	30 wells	100	300	Maximum		x					8,870	1 51	107 92	107 92	0	150 00	0	11 10		9.00 per acre-foot	9 00	14 59	0	0	24 69		16 25	
Merced	Merced	Merced	1919	130,000	165,000	Merced River					x	x			x	95,000	2 50	63 15	25 80	0	75 00	0	1 55		None			0	0	1 55		62	
Modesto	Modesto	Stanislaus	1887	81,183	75,000	Tuolumne River	0			17,273	21,496	8,985			12,898	60,652	2 50	51 98	51 11	87	90 00	05	5 22		None			36	1 23	3 63	3 68	1 45	1 47
Oakdale	Oakdale	Stanislaus, San Joaquin	1909	74,236	65,000	Stanislaus River	2			5,019	8,818				3,459	19,296	3 30	32 33	32 33	0	54 25	0	3 69		None			0	0	3 69		1 12	
South San Joaquin	Manteca	San Joaquin	1909	71,112	67,100	Stanislaus River	0			9,043	32,185				9,375	51,203	2 40	60 96	60 11	0	100 00	0	6 25		None			0	57	5 88		2 45	
Terra Bella	Terra Bella	Tulare	1915	12,285	10,980	Wells and streams	100	392	1,739	2,276					102	4,117	1 57	81 40	81 40	0	100 00	0	10 75		$10.00 per acre-foot	10 00	15 70	0	4 75	21 70		13 82	
Tranquillity	Tranquillity	Fresno	1918	10,750	10,350	Kings and San Joaquin Rivers	20	12			7,000	3,000				10,000	1 80	24 19	24 19	0	150 00	0	6 00		None			0	2 25	3 75		2 08	
Turlock	Turlock	Stanislaus, Merced	1887	181,400	165,000	Tuolumne River	0			x	x	x			x	105,000	1 60	37 30	36 64	06	65 00	04	3 45		None			63	1 07	2 05	2 09	1 28	1 31
Waterford	Waterford	Stanislaus	1914	13,577	10 747	Tuolumne River	0			1,361	1,130			200	x	3,108	3 20	49 35	49 35	0	90 00	0	1 00		None			0	0 44	3 56		1 11	
West Side	Tracy	San Joaquin	1915	11 800	11,765	San Joaquin River	100	93		x	3,823	4,300			x	10,671	2 00	16 19	16 19	0	100 00	0	7 50		None			0	15	7 35		3 68	
SOUTHERN CALIFORNIA																																	
Beaumont	Beaumont	Riverside	1919	3,176	2,900	Wells and creeks	50	50 to 100		2,036						2,036	64	72 40	72 40	0	80 00	0	7 20		$7.00 per acre		7 00	0	0	14 20		22 19	
Imperial	El Centro	Imperial	1911	603,810	515,000	Colorado River	0		x	x	x	x			x	413,400	3 00	26 50	23 18	0	100 00	0	1 80		1.00 per acre-foot (+ $3.17)	1 00	3 00	0	0	7 67		2 66	
Little Rock Creek	Little Rock	Los Angeles	1802	3,073	3,050	Little Rock Creek	2			1,750						1,750	1 60	100 22	100 22	0	100 00	0	6 88		None			0	0	6 88		4 30	
Newport Mesa	Costa Mesa	Orange	1918	670		Wells	100	140		100	10				40	150	2 00	71 62	74 62	0	400 00	0	11 70	Alfalfa	$1.00 per irrigation		5 00	0	0	16 70		8 35	
Newport Mesa	Costa Mesa	Orange															4 50					0	11 70	Orchard	75 per irrigation		4 50	0	0	16 20		7 20	
Palmdale	Palmdale	Los Angeles	1916	4,756	1 650	Little Rock Creek	0			500						500	1 33	83 56	93 56	0	100 00	0	4 04		None			0	0	4 04		3 04	
San Ysidro	San Ysidro	San Diego	1912	402	402	Wells	100	75 to 168	x	x	x					130	2 36	50 82	50 82	0	225 00	0	9 00		$12.00 per acre		12 00	0	0	21 00		8 90	
Los Angeles Municipal Improvement District No 2	Los Angeles	Los Angeles	1916	11,010		Los Angeles aqueduct											1 30	35 42	28 34	57 08	250 00	42	2 95	All (av.)	0.014 per 100 cu ft	6 10	7 93	1 32	0	9 56	9 98	7 35	7 68
																	1 60				300 00	42	3 55	Deciduous	0.014 per 100 cu ft	6 10	8 10	1 59	0	8 06	8 48	8 06	8 48
																	2 00				500 00	42	5 91	Citrus	0.014 per 100 cu ft	6 10	12 20	2 64	0	15 47	15 80	7 74	7 95
																	3 00				750 00	42	7 87	Alfalfa	0.014 per 100 cu. ft	6 10	18 30	4 32	0	19 93	20 35	6 64	6 78
Los Angeles County Water Works District No 3	Los Angeles	Los Angeles	1911	74,535		Los Angeles aqueduct			8,495	15,581	7,078				25,324	56,278	1 30	31 95	28 71	4 51	200 00	27	3 19	All	0.014 per 100 cu ft	6 10	7 83	1 24	0	9 88	10 15	7 60	7 81
																	1 60				300 00	27	4 78	Deciduous	0.014 per 100 cu ft	6 10	0 10	1 86	0	9 02	9 29	9 02	9 29
																	2 00				500 00	27	7 97	Citrus	0.014 per 100 cu ft	6 10	12 20	3 10	0	17 07	17 34	8 54	8 67
																	3 00				200 00	27	3 19	Alfalfa	0.014 per 100 cu. ft	6 10	18 30	1 24	0	20 25	20 52	6 75	6 84

REMARKS—[1] Estimated. [2] Operation and interest charges on irrigation works. [3] Consolidated Canal Co.'s water charge. [4] Acreage for U. S. only; 150,000 additional acres in Mexico. [5] Average of eleven mutual companies' assessments. [6] Aqueduct bonds not included. [7] Used 1922-23 tax rate and included aqueduct bond tax. [x] Acreage unknown.

PLATE II.

FIG. 1. Pumping plant furnishing 1500 cubic feet of water per second to Central Canal, Glenn-Colusa Irrigation District.

FIG. 2. Flooding a rice field in Sacramento Valley.

T
A fe
vary
tion

D
ann
or a
sent
wor
be c

I
in t
Fir
asse
onl
on
reti
reti
I
a s
Ho
her

cos
op

sou
to
ma
he

sy
ta

ca

fe

di
di
of
ac
is
ac

ta

p

o

PLATE II.

FIG. 1. Pumping plant furnishing 1500 cubic feet of water per second to Central Canal, Glenn-Colusa Irrigation District.

FIG. 2. Flooding a rice field in Sacramento Valley.

and 1922-1923 to an acre basis and taking their average. This method was decided upon because the expenses of one year overlap with the next year in many districts, the average for the two years giving fairer results. Generally this average may be taken as referring to the calendar year 1922.

Column 27, "Water charge per acre for average amount used" is derived either from Column 25 or from the product of columns 17 and 26.

Column 28, "Bond principal tax per acre" gives the average of bonds retired per acre for the last two years. Column 29, "Permanent improvements tax per acre" shows average portion of the tax for the past two years that has gone into capital improvements. These two columns come under the head of "Deductions average past two years" as both should be deducted from the total tax per acre and thus charged to capital account rather than annual cost of water.

The last four columns of the table are the final results obtained from calculations based on the previous columns. Column 30, "Cost of water per acre for average amount used, excluding interest on retired bonds" is equal to column 23 plus column 27 minus columns 28 and 29. Column 31, "Cost of water per acre for average amount used, including interest on retired bonds" is equal to column 30 plus column 22. Column 32, "Cost of water per acre foot for the average amount used, excluding interest on retired bonds" is equal to column 30 divided by column 17. Column 33, "Cost of water per acre foot for the average amount used, including interest on retired bonds" is equal to column 31 divided by column 17.

The conditions affecting the annual cost of water vary so much in different districts that there is no fair basis of comparison. Some districts deliver water to every 10 acres, others to every 160 acres, leaving the farmers to take care of the remaining distribution system. In some projects where gravity water is depeneded upon without storage, the irrigator supplements this supply by a private pumping plant to tide over a dry season, and thus adds to his regular irrigation district charges. One district may have expensive storage reservoirs, diversion works, pumping plants, or a concrete pipe or lined canal distribution system, while another district will depend entirely on unstored gravity water with unlined ditches. Of 37 districts listed in Table 8, 17 have no water tolls and depend entirely on taxes for revenue, 10 have taxes plus flat rate per acre water tolls, and 10 have taxes plus measured rate water tolls. These facts further complicate comparisons of costs on per acre or per acre-foot bases. Districts having a higher bonded debt per acre naturally have higher interest charges to pay. These charges in some cases amount to more than the cost of operation and maintenance.

Many of the above facts are shown in Table 8; the irrigator should weigh them carefully before coming to the conclusion that he is paying too much for water in comparison with other districts.

Notwithstanding the disadvantages mentioned, some idea of the variation of the annual cost of irrigation water under different conditions may be obtained from summaries of columns 30 and 32, which give costs on the per acre or per acre-foot basis respectively, excluding interest on retired bonds. It is impracticable to give summaries of columns 31 and 33, which include interest on retired bonds, as only a few districts have retired bonds. The interest on these is small, as the table shows,

and would have very little effect on average costs. The data in Table 8 are summarized below.

Duty of water—Table 9 is a summary of column 17 in Table 8 showing the minimum and maximum duty of water under irrigation districts in northern, central, and southern California and for the state as a whole. The number of districts considered is also shown.

TABLE 9 SUMMARY OF DUTY OF WATER UNDER IRRIGATION DISTRICTS.

Section of California	Number of districts	Quantity of water used, per acre	
		Minimum, acre-feet	Maximum, acre-feet
Northern	12	0 50	9 00
Central	17	1 50	3 30
Southern	8	64	3 00
Entire state	37	.50	9 00

The minimum duty of 0.50 acre-foot per acre as shown in the above summary is for a system under which deciduous fruits and olives are grown almost exclusively, the soil is retentive, and the average rainfall is about 27 inches. This accounts for the small amount of water used. The maximum duty of 9 acre-feet per acre is found under a system which has plenty of water and the entire crop is rice. Both of these examples are extreme cases.

Annual cost of irrigation water—Table 10 is a summary of columns 30 and 32 in Table 8, showing the minimum and maximum cost of water under irrigation districts in northern, central and southern California and for the state as a whole. The number of districts considered is also shown.

TABLE 10 SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS.

Section of California	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	12	$3 28	$12 00	$0 37	$18 00
Central	17	90	24 69	53	16 35
Southern	8	4 04	21 00	2 66	22 19
Entire state	37	90	24 69	37	22 19

The lowest annual cost of $0.90 per acre is for a system which depends upon gravity water without storage. Most of the crops that need water after July 15 are irrigated by private pumping plants and the cost of this irrigation is not shown. On the other hand, the highest cost of $24.69 is under a district where all the water is pumped through an average lift of about 300 feet, the distribution system consists of steel, redwood and concrete pipe, and the average cost of litigation for the past two years has been about $5.00 per acre. These two illustrations will give some idea of the reasons for the wide variations in costs per acre among the different districts.

In many cases the annual costs shown on the acre-foot basis are theoretical only. This is especially true where the costs consist of assessments alone or assessments and flat water tolls per acre, and is due to the fact that the cost per acre-foot is obtained by dividing the cost per acre by the duty of water. Thus the maximum cost per acre-foot of $22.19 is found under a district which has an annual cost per acre of $14.20 with a duty of water of 0.64 acre-foot. However, water is not abundant in this section and it would undoubtedly cost $22.19 or more to develop and distribute one acre-foot of water. This district has a concrete and steel pipe distribution system and pumps 50 per cent of its water from 50 to 150 feet. The minimum cost per acre-foot of $0.37 is for a system where rice is grown entirely with annual cost of $3.37 per acre and a duty of 9 acre-feet. Seventy per cent of the water was pumped through the low lift of 5 feet. Only a small acreage was irrigated in 1922 and water was plentiful

Annual cost of gravity water—Table 11 is a summary of columns 30 and 32 in Table 8 showing the minimum and maximum annual cost of water under irrigation districts delivering all gravity water. Figures are shown for northern, central, and southern California and for the state as a whole.

TABLE 11—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS DELIVERING ALL GRAVITY WATER.

Section of California	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	5	$4 70	$9 60	$0 78	$18 00
Central	8	90	5 88	53	2 45
Southern	2	4 04	7 97	2 66	3 04
Entire state	15	90	9 60	53	18 00

The higher costs are generally found under districts which have stored water or expensive distribution systems, while the lower costs as a rule are in districts having no stored water. The maximum cost per acre-foot of $18.00 is for a district which only uses 0.50 per acre-foot of water. The cost per acre is $9.00, hence cost per acre-foot is high.

The minimum cost per acre-foot of $0.53 as shown by one district and the minimum cost per acre of $0.90 as shown by another are for systems having no storage. Some irrigators in both districts have supplemented their gravity supply by privately installed pumping plants.

Annual cost of pumped water—Table 12 is a summary of columns 30 and 32 in Table 8 showing the minimum and maximum annual cost of water under districts delivering all pumped water. Figures are shown for northern, central, and southern California and for the state as a whole.

TABLE 12—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS DELIVERING ALL PUMPED WATER.

Section of California	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	3	$4 08	$12 00	$1 56	$6 00
Central	5	7 35	21 69	3 68	16 35
Southern	2	16 20	21 00	8 35	10 80
Entire state	10	4 08	24 69	1 56	16 35

Of the districts shown in Table 8, ten deliver pumped water entirely. The average lifts vary from 24 feet to 392 feet. The maximum lift for part of the water in one district was 601 feet. The maximum costs of $24.69 per acre and $16.35 per acre-foot are for a system which has an average lift of 300 feet, the highest lift being 460 feet. However, $5.00 of this $24.69 per acre cost should be charged to litigation over pumping rights. The minimum cost of $4.08 per acre and $1.56 per acre-foot is for a district pumping water from Sacramento River through a lift of 24 feet.

Cost of water for various crops—As was the case under public utilities, it is difficult to make accurate comparisons on the cost of irrigation water according to crops grown because many districts furnish water to more than one kind of crop and very few keep records making the segregation possible. However, the following tables, giving summaries of columns 30 and 32 in Table 8, in a measure indicate the variations in the annual costs of water for citrus trees, deciduous trees and vines, alfalfa, and rice. Figures are shown for northern, central and southern California and for the state as a whole.

TABLE 13—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS IN NORTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	5	$3 28	$9 60	$1 13	$5 64
Deciduous trees and vines	10	3 28	9 60	78	18 00
Alfalfa	6	3 28	12 00	78	6 00
Rice	4	3 37	9 33	37	1 56

TABLE 14—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS IN CENTRAL CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	3	$0 90	$24 69	$0 60	$16 35
Deciduous trees and vines	11	90	24 69	53	16 35
Alfalfa	11	90	9 78	53	6 23
Rice	1	3 56	3 56	1 11	1 11

TABLE 15—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS IN SOUTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	4	$7 97	$21 00	$2 66	$8 90
Deciduous trees and vines	8	4 04	21 00	2 66	22 19
Alfalfa	5	7 97	21 00	2 66	8 90
Rice	None				

TABLE 16—SUMMARY OF ANNUAL COST OF WATER UNDER IRRIGATION DISTRICTS IN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of districts considered	Cost of water excluding interest on retired bonds			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	12	$0 90	$24 69	$0 60	$16 35
Deciduous trees and vines	32	90	24 69	53	22 19
Alfalfa	25	90	21 00	53	8 90
Rice	5	3 37	9 33	37	1 56

The average annual cost of water to the irrigator in the state as a whole, for various kinds of crops, as shown by Table 16, indicates that the higher costs per acre and per acre-foot are under districts where citrus trees are grown. Then follow in order the costs for irrigating deciduous trees and vines, alfalfa, and rice. Hence as would be expected, districts having conditions favorable for growing the higher grade crops are able to stand the greater costs, necessary in many cases, to develop a dependable water supply.

The high costs of water per acre for rice and alfalfa as shown in some of the tables is due generally to the larger quantity of water used for those crops.

PLATE III.

FIG. 1. A combined power and irrigation canal in the Sierra Nevada above Sacramento Valley.

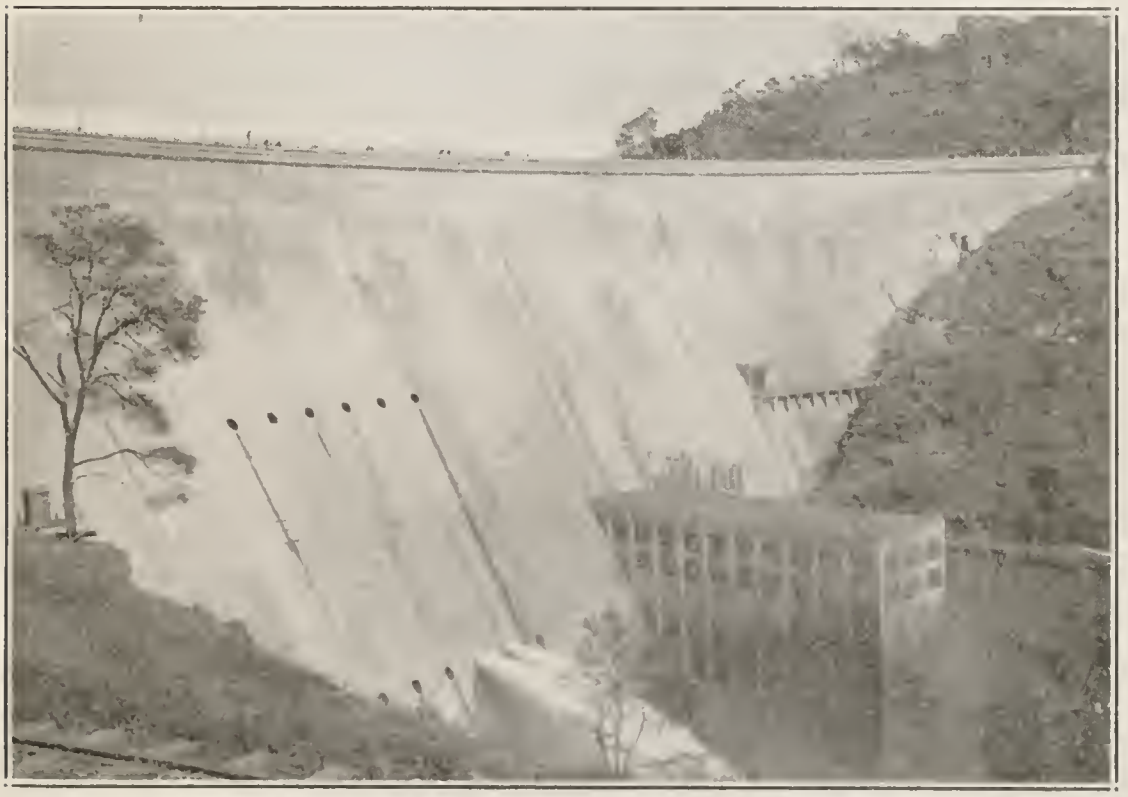

FIG. 2. Don Pedro storage dam of Modesto and Turlock Irrigation Districts showing hydro-electric plant below.

MUTUAL WATER COMPANIES.

Nature of a mutual company—Under the California laws a mutual water company is defined as "any private corporation or association organization organized for the purpose of delivering water solely to its stockholders or members at cost."* This type of enterprise is also known under the name of cooperative water company. A mutual company may be considered a special form of private company in which the stock represents water rights and is entirely owned by those who are to be served.

Organization and financing—Mutual water companies are incorporated under the general law of the state regulating the organization of private companies. Many of the mutual companies have been organized as part of the program of enterprises engaged in the subdivision and sale of land. Usually the land companies built the irrigation systems or portions of them in advance of settlement, and organized the mutual companies on paper. Shares of stock were then sold to settlers together with the land. In most cases the settlers obtain control of the irrigation system after 50 per cent of the stock has been paid for.

Some mutual companies have been organized by the landowners directly, who worked together for the development of a water supply and the construction of an irrigation system. In such cases the works usually were built a little at a time and were not completed for several years, the period depending upon how construction funds were secured. Funds have been raised by subscriptions to capital, by direct assessment of the capital stock, by bonds, and by small loans. In a few cases settlers have cooperated in building works by their own labor.

The affairs of mutual companies are controlled by a board of directors elected annually by the stockholders. The president is elected by the directors from one of their own number. As a rule the secretary keeps the books and records and computes and collects water charges. A superintendent is placed in charge of water delivery, operation, and maintenance. The number of zanjeros assisting him in delivering the water depends upon the size of the company.

Water stock—One share of water stock per acre is generally the amount issued by mutual water companies, although in some cases as high as 200 shares per acre have been issued, while in other instances one share covers 640 acres. The par and market values of stocks likewise are eccentric, and in order to make comparisons between companies it is necessary to reduce values to an acreage basis. Each share of stock may carry with it a right to a certain amount of water.

Under the California law a mutual company† may, under its by-laws, make the stock appurtenant to the land. However, a few have done this under the articles of incorporation instead. Where this provision of the law is exercised to the full extent the water can not be sold separately from the land. Although the stock may have a high par value, it apparently has no independent market value; nevertheless, such value does exist under cover of the land prices. A method sometimes used to fix the price of unsold shares of stock after the first year, by certain companies which make the water appurtenant to the land, is to require

*Chapter 191 of the Laws of 1917.

†Portions of several pages in this discussion on mutual water companies were compiled from original notes of the late C. E. Tait, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Dept. of Agriculture.

the subsequent purchaser to pay the par value, plus all assessments to date plus simple interest.

Some companies make the water or stock appurtenant only to the large tract of land to be subdivided and to the adjoining lands, and allow transfers of shares of stock between individual land owners within this area so long as these transfers are handled through the company's office. Under this plan a user may invest in as many shares as he needs, depending upon the crops being grown.

Other companies prefer not to make the stock appurtenant to any lands. Under such companies the directors would not construct laterals to reach lands outside of the territory originally intended to be irrigated. Since the land owner or stockholder cannot afford to carry the water very far at his own expense, the result is about the same as that brought about by companies which make the water appurtenant to certain lands. The advantage of making the stock non-appurtenant is that under a system where crops are diversified, each requiring a different amount of water, the landowner needs to invest in only as many shares as he can get along with. If the stock is appurtenant and the ratio of shares to the acre is fixed, he must provide for the max mum water requirements of any crop that may be grown, and if he has to pay assessments on these shares he is inclined to demand all the water his shares entitle him to.

A few companies which make the water appurtenant to the land, allow shares to be rented by one stockholder to another for periods not exceeding four years. This limitation is to safeguard the owner of the shares against any claim of a prescriptive right being set up by the renter of the shares by using the water five years or more.

Where the stock can be transferred from one land owner to another separately from the land, it acquires a market value which, with a few exceptions, is higher than the par value. This market value of shares is influenced by the agricultural values producible by the use of the water, by the character of the water right, indebtedness of company, cost of operation, and other minor factors, as well as the original cost.

FACTORS IN ANNUAL COST OF WATER UNDER MUTUAL WATER COMPANIES.

The principal factors in the annual cost of water considered in this report are annual assessments, water rate, duty of water, and interest on capital stock.

Assessments and water rates—Companies differ to some extent in their finances. Under the California law all stock is assessable. Some companies raise all their funds by assessments on capital stock. Under such a system there is little inducement for the stockholder to use water economically. Where crops are uniform throughout the project it works fairly well.

The other extreme is to meet all expenses by the collection of a water rate or charge, proportional to the amount used. From time to time the charge is fixed by the board of directors in anticipation of the future expenses of the company.

Some companies using a more logical plan fix a rate to water using stockholders sufficient to meet the annual cost of distribution, leaving the requirements of capital investment and improvements to the system to be taken care of by assessment on all the stock issued. This method

is not conducive to either speculation in capital stock or extravagant use of water.

Many different kinds of rate schedules are used by the companies. The rates may be on a measured basis of so much per hour-inch per irrigation, per day-inch, per acre-foot, or per cubic foot; or on a flat rate basis of so much per acre or per miner's inch per season, irrespective of the amount of water used. Some companies have a constant rate for all water used, others different rates for winter and summer, others different rates for each month, others different rates for day and night use, others have a rate decreasing as the amount of water used increases, and others have a minimum charge.

Mutual water companies that make no charges for water generally assess the stock every year. Companies that use a water charge to meet their running expenses may not assess the stock every year, but only when some improvements are to be made on their system or when payments are to be met on loans or bonds.

However, it rarely if ever happens that a company does not make at least one assessment in five years. For this reason, in determining the annual cost of irrigation water for this report, the average of the assessments for five years terminating with 1922 has been used rather than the assessment for 1922 alone.

Where any part of the revenues are applied on retiring bonds or loans, proper deduction should be made from the total annual cost. This is not a proper charge to annual operating cost as payments on principal belong to the capital account.

Interest on capital stock—For purposes of comparison, the value of capital stock for companies has been reduced to an acreage basis. If the stock had an established market value in 1922 this was taken in making the reductions. If it had no apparent market value due to being appurtenant to the land or for other reasons, the original par value was used in determining the value per acre. Interest on this value of capital stock, which represents the stockholder's investment for water, was calculated at 6 per cent.

Duty of water—The amount of water used by the irrigator becomes a factor in the annual cost of water when it is desired to obtain this on the acre or the acre-foot basis. The duty of water data given in this report represent the average amount of water delivered to the irrigator; that is, it is the amount of water he pays for. In most cases this may be considered the net duty of water for the system.

COST OF WATER UNDER MUTUAL WATER COMPANIES.

Description of tables 17 and 18—Table 17 has been prepared showing the annual cost of water to irrigators under the most important mutual water companies in northern and central California.

There are 31 columns in the tabulations. In addition to the cost of water to irrigators, the table shows factors which affect the cost of water and many other useful facts. Many of the column headings are self explanatory and will not be taken up in detail here.

Column 3, "Year organized," in many cases will give some idea of the age of water rights or system; but this is not a fixed rule.

Column 19, "Value of stock per acre" is obtained by multiplying column 17, "Market value of stock per share" by column 18, "Average

TABLE 17.—COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Mutual Water Companies in Northern and Central California. 1922.

1	2	3	4	5	6	Area irrigated							Capital stock					Factors in annual cost of water					Annual cost of water					
						7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Per acre for first acre-foot		Per acre for average amount used		Per acre-foot for average amount used	
Name of company	Location	Year organized	Source of water supply	Lift feet	Percentage of water pumped	Citrus trees, acres	Deciduous trees and vines, acres	Alfalfa, acres	Grain, acres	Rice, acres	Miscellaneous, acres	Total, acres	Average duty of water per acre at delivery gate, acre-feet	Number of shares of stock issued	Par value of stock per share	Market value of stock per share	Average number of shares per acre	Value of stock per acre	Interest on value of capital stock per acre at 6 per cent	Average annual assessment per acre	Schedule	Per acre foot	Water charge per acre for average amount used	Amount per acre deposited in sinking fund or charged to capital stock	26 Excluding interest on value of capital stock	27 Including interest on value of capital stock	28 Excluding interest on value of capital stock	29 Including interest on value of capital stock	30 Excluding interest on value of capital stock	31 Including interest on value of capital stock
NORTHERN CALIFORNIA.																													
Butte Glenn Mutual Water Co	Dodgeland	1920	Western Canal Co	8	100		12	3		180		195	5 60	2,174	$7 00		1 000	$7 00	$0 42	$0 25	$13.00 per acre, rice		$13 00	$0 00	$13 25	$13 67	$13 25	$13 67	$2 37	$2 44
Butte Glenn Mutual Water Co													1 06						0 42	0 25	3.80 per acre, general				4 05	4 47	4 05	4 47	3 82	3 92
Durham State Land Settlement	Durham		Butte Creek	0	0		200	1,200			1,800	3,200	1 25						0 00	0 00	1.00 per ac.-ft	$1 00	1 25	0 00	1 10	4 10	1 35	4 35	1 08	3 48
Elkhorn Mutual Water Co	Sacramento	1918	Sacramento River	24	100		110	352		0	1,607	2,069	1 05	6,000	10 00		1 000	45 00	2 70	1 00	3.00 per ac.-ft	3 00	3 15	0 00	4 00	10 70	4 15	6 85	3 95	6 52
Hallwood Irrigation Co	Marysville	1910	Yuba River	0	0		x	x		x	x	3,000	*3 00	6,117	5 00	$23 00	1 000	23 00	1 38	1 50	None				1 50	2 88	1 50	2 88	0 50	0 96
Natomas Central Mutual Water Co	Sacramento	1921	Sacramento River	24	100		60	367			385	821	0 86	19,280	10 00		1 000	32 00	1 92	0 50	4.00 per ac.-ft	4 00	4 44	0 00	4 50	6 42	3 94	5 86	4 58	6 82
Natomas Riverside Mutual Water Co	Sacramento	1920	Sacramento River	24	100		111	537			735	1,383	1 00	3,547	10 00		1 000	47 00	2 82	1 00	4.00 per ac.-ft	4 00	4 00	0 00	5 00	7 82	5 00	7 82	5 00	7 82
Orangevale Water Co	Orangevale		Northfork Ditch Co	0	0		x					2,200	1 52					120 00	1 20	0 50	24.00 per M. I. per season		4 80	0 00	5 30	6 50	5 30	6 50	2 76	3 39
Orland Project, U. S. R. S	Orland	1916	Stony Creek	0	0	170	3,192	6,885		694	4,178	15,119	3 34				1 000	0 00	0 00	3 30	1.75 per acre, 3 ac.-ft		1 81	3 30	1 75	1 75	1 81	1 83	0 55	0 55
Western Canal Co	Oroville	1914	Lake Almanor	0	0		x	x			13,034	x	14,271	5 94	20,000	1 00		1 000	1 00	0 06	0 00	6.00 per acre, rice		6 00	0 00	6 00	6 06	6 00	6 06	1 01	1 02
Western Canal Co													1 06						0 06	0 00	2.00 per acre, general		2 00	0 00	2 00	2 06	2 00	2 06	1 89	1 94
CENTRAL CALIFORNIA.																													
Carter Water Co	Tehachapi	1922	Wells	70	100		140					140	0 43	140				*50 00	3 00	0 00	$0.32 per day in. [4]	8 07	3 47	0 00	8 07	11 07	3 47	6 47	8 07	15 05
Consolidated Peoples Water Ditch	Visalia	1874	Kaweah River	0	0		4,400	4,100			6,500	15,000	*3 00	57	100 00	1,500 00	1/160	9 38	0 56	0 56	None			0 00	0 68	1 24	0 68	1 24	0 23	0 41
Delhi State Land Settlement	Delhi	1920	Turlock Irrigation District	30	50		700	1,200			250	2,150	4 00								District tax $2.15 [5]				3 91		3 91		0 98	
Evans Ditch Co	Visalia	1854	Kaweah River	0	0		x	x		x		800	*2 00	992	100 00	15 00	1 000	15 00	0 90	3 50	None			0 00	3 50	4 40	3 50	4 40	1 75	2 20
First Edison Well Co	Edison	1909	Wells	120	100	255	141					396	3 00	385	50 00		1 000	50 00	3 00	4 95	15.00 per 1,440 hour inches [6]	5 04	15 12	0 00	9 95	12 99	20 07	23 07	6 69	7 69
Jennings Ditch Water Co	Visalia		St. Johns River	0	0		100	300			230	630	*3 20	84	40 00	50 00	0 100	5 00	0 30	2 98	None			0 00	2 28	3 28	2 28	3 28	0 93	1 03
Lakeside Ditch	Hanford	1873	Kaweah River	0	0		x	x	x			19,800	*2 50	20,197	1 00	5 00	1 000	5 00	0 30	0 75	None			0 00	0 78	1 08	0 78	1 08	0 32	0 44
Last Chance Water Ditch Co	Hanford	1873	Kings River	0	0		x	x	x		x	30,000	1 68	45	1,000 00	1,800 00	1/640	2 81	0 17	0 85	None			0 00	0 66	0 83	0 66	0 83	0 40	0 49
Blowers Side Ditch Co	Hanford	1911	Last Chance Ditch	0	0		530					530	1 68					2 81	0 17	0 99	None			0 00	0 79	0 96	0 79	0 96	0 47	0 57
Independent Ditch Co	Hanford	1884	Last Chance Ditch	0	* 0		800	x	x			3,200	1 68					1 37	0 26	0 96	None			0 00	0 17	1 05	0 79	1 05	0 47	0 63
Lemoore Canal and Irrigation Co	Lemoore	1902	Kings River	0	0		6,160	24,800	7,500		13,340	52,300	2 10	53	2,000 00	4 800 00	1/640	7 50	0 45	0 63	None			0 00	0 63	1 08	0 63	1 08	0 30	0 51
Lerdo Mutual Water Co. No. 9	Bakersfield	1920	Wells	100	100		394					394	3 00	394	1 00	35 00	1 000	35 00	2 10	0 00	10.00 per acre		10 00	0 00	10 00	12 10	10 00	12 10	3 33	4 03
Modoc Ditch Co	Visalia	1894	St. Johns River	0	0		84	2,000			1,516	3,600	*2 70	100	100 00	400 00	0 025	10 00	0 60	0 80	None			0 00	0 80	1 40	0 80	1 40	0 30	0 52
Patterson Water Co	Patterson		San Joaquin River	60	100		1,500	13,000				14,500	1 57	14,500	10 00		1 000	10 00	0 60	0 00	7.00 per acre		7 00	0 00	7 00	7 60	7 00	7 60	4 46	4 84
Peoples Ditch Co	Hanford	1873	Kings River	0	0		x	x			x	50,000	2 30	63[3]	1,000 00		1/640	6 87	0 41	0 71	None			0 00	0 51	0 92	0 51	0 92	0 22	0 40
New Dead Ditch Co	Hanford	1885	Peoples Ditch	0	0		x	x			x	1,000	2 30	72[3]	100 00		1/160	87 50	0 45	0 82	None			0 00	0 51	1 07	0 51	1 07	0 27	0 47
Riverside Ditch	Hanford	1891	Peoples Ditch	0	0		x	x			x	7,300	2 30	92	100 00	100 00	1/80	8 12	0 49	*1 03	None			0 00	0 83	1 32	0 83	1 32	0 36	0 57
Pioneer Water Co	Pattersville	1888	Tule River and Wells	75	12	x	x			(Beans)		3,000	1 17	3,600	100 00	15 00	1 200	18 00	1 08	0 24	0.146 per day inch [4]	2 95	5 45	0 00	3 19	4 27	3 69	4 77	3 15	4 08
Salinas Land Co	Kings City	1918	Wells	168-299	100		40			2,760		2,800	1 20						0 00	0 00	10 48 per acre		10 48	0 00	10 48		8 74			
Second Edison Well Co	Edison	1900	Wells	168	100	242	8					300	3 43	276	50 00		1 000	50 00	3 00	4 57	24.50 per 1,440 hour inches [6]	8 24	28 80	0 00	12 81	15 61	33 17	36 17	9 18	10 33
Tehachapi Orchards Water Co	Tehachapi	1914	Wells	100	100		160					160	0 36	160		50 00	1 000	50 00	3 00	0 00	0.36 per day inch [4]	9 08	4 18	0 00	0 08	12 08	4 18	7 18	4 18	15 61
Tehachapi Valley Water Co	Tehachapi	1911	Wells	135	100		400					400	0 45	766	100 00	100 00	1 000	100 00	6 00	0 45	0.65 per 30 inch-hours	13 11	5 90	0 00	13 56	19 56	6 35	12 35	14 11	27 44
Tulare Irrigation Co	Visalia	1874	Kaweah River	0	0		940	1,600			2,540	3,300	*2 70	321	100 00	75 00	0 100	7 50	0 45	1 78	None [4]			0 00	1 78	2 23	1 78	2 23	0 66	0 83
Uphill Ditch Co	Visalia	1901	St. Johns River	0	0		124	1,148	x		x	1,873	*2 00	700	10 00	40 00	0 350	14 00	0 84	0 98	None [4]			0 00	0 98	1 82	0 98	1 82	0 49	0 91
Watson Ditch Co	Visalia	1853	Kaweah River	0	0		x	x	x		x	3,000	*2 00	610	100 00	50 00	0 200	10 00	0 60	1 12	None			0 00	1 12	1 72	1 12	1 72	0 56	0 86
Wutchumna Water Co	Visalia	1872	Kaweah River	0	0		5,600	900	x		x	7,500	*2 50	91	1,000 00	1,800 00	0 012	21 60	1 30	1 94	None			0 00	1 94	3 24	1 94	3 24	0 78	1 30

REMARKS.—[1] Estimated cost of system per acre. [2] Includes Last Chance Water Ditch Co. stock. [3] Includes Peoples Ditch Co. stock. [4] Includes Last Chance Water Ditch Co. assessments. [5] Includes Peoples Ditch Co. assessments. [6] On basis of 1 miner's inch for 5 acres. [7] 25 cents for first additional acre-foot. [8] 50 miner's inches equals 1 second-foot. [9] 40 miner's inches equals 1 second-foot. x Acreage unknown. * Estimated.

is not c
use of w
Many
The rat
irrigatio
rate bas
of the a
all wate
different
use, oth
and oth
Mutu
assess tl
their ru
when so
ments a
Howe
least on
annual
ments f
the asse
Where
loans, p
This is
principa

Intere
capital s
stock ha
the redu
tenant t
determi
which r
at 6 per

Duty
factor i
the acre
report r
that is,
be consi

Descri
the ann
water c
There
water t
water a
self expl
Colun
the age
Colun
column

TABLE 18.—COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Mutual Water Companies in Southern California. 1922.

Name of company (1)	Location (2)	Year organized (3)	Source of water supply (4)	Lift, feet (5)	Percentage water pumped (6)	Area irrigated: Citrus trees, acres (7)	Area irrigated: Deciduous trees, acres (8)	Area irrigated: Alfalfa, acres (9)	Area irrigated: Miscellaneous, acres (10)	Area irrigated: Total, acres (11)	Average duty of water per acre, acre-feet (12)	Capital stock: Number of shares issued (13)	Capital stock: Par value of stock per share (14)	Capital stock: Market value stock per share (15)	Capital stock: Average number shares per acre (16)	Capital stock: Value of stock per acre (17)	Factors in annual cost of water: Interest on value of capital stock per acre at 6 per cent (18)	Factors: Average annual assessment per acre for past 5 years (19)	Factors: Water rate: Per hour-inch (20)	Factors: Water rate: Per acre-foot (21)	Factors: Water charge per acre for average amount used (22)	Factors: Amount per acre deposited in sinking fund or charged to capital stock (23)	Annual cost of water: For first acre-foot: Excluding interest on value of capital stock (24)	For first acre-foot: Including interest on value of capital stock (25)	Per acre for average amount used: Excluding interest on value of capital stock (26)	Per acre for average amount used: Including interest on value of capital stock (27)	Per acre-foot for average amount used: Excluding interest on value of capital stock (28)	Per acre-foot for average amount used: Including interest on value of capital stock (29)
MUTUAL COMPANIES.																												
Anaheim Union Water Co.	Anaheim	1884	Santa Ana River	100		500	7,500			8,000	*1 22	8,004	$100 00	$100 00	1 00	$100 00	$6 00	$5 60	$ 0120	$7 26	$8 86	$1 25	$11 61	$17 61	$13 21	$19 21	$10 83	$15 75
Arroyo Ditch and Water Co.	Downey	1885	Rio Hondo		10	x	x			4,000	*1 00	3,700	5 00	30 00	1.00	30 00	1 80	2 50	.0055	3 33	3 33	0 10	5 73	7 53	5 73	7 53	5 73	7 53
Azusa Irrigating Co.	Azusa	1886	San Gabriel River		8	3,929				3,929	1 37	11,891	15 00	100 00	3 00	300 00	18 00	3 60	.00487	2 95	4 04	1 00	5 55	23 55	6 64	24 64	4 85	17 88
Banning Heights Mutual Water Co.	Banning	1913	White Water River		0		*700			*700	*1 00	14,000	15 00	15 00	10 00	150 00	9 00	None	.0041	2 50	2 50	None	2 50	11 50	2 50	11 50	2 50	11 50
Banning Water Co.	Banning	1884	San Gorgonio Creek				2,900			2,000	2 73	3,245	50 00	200 00	1.10	220 00	13 20	10 18	None	None	None	0 69	9 49	22 69	9 49	22 69	3 47	8 31
Beardslee Water Ditch Co.	Duarte	1881	San Gabriel River		0	500	200		100	800	1 67	630	33 00	200 00	0 80	160 00	9 60	7 52	None	None	None	2 00	5 52	15 12	5 52	15 12	3 30	9 06
Bear Valley Mutual Water Co.	Redlands	1903	Santa Ana River		0					14,300																		
Crafton Water Co.	Redlands	1857	B V. M. W. Co.		0	1,800				1,800	2 00	3,321	100 00	250 00	1 00	250 00	15 00	5 80	None	None	None	0 78	5 02	20 02	5 02	20 02	2 51	10 01
Redlands Heights Water Co.	Redlands	1891	Crafton Water Co.		0	1,200				1,200	2 00	1,411	100 00	225 00	1 00	225 00	13 50	12 00	None	None	None	1 36	10 64	24 14	10 64	24 14	5 32	12 07
East Redlands Water Co.	Redlands	1886	B. V. M W. Co.		0	443				443	2 00	443	100 00	150 00	1 00	150 00	9 00	8 50	None	None	None	0 71	7 79	16 79	7 79	16 79	3 90	8 40
Lugonia Park Water Co.	Redlands	1894	B V. M. W. Co.		0	200				200	1 89	196	100 00		1 00	100 00	6 00	13 50	None	None	None	1 49	12 01	18 01	12 01	18 01	6 35	9 53
Redlands Water Co.	Redlands	1882	B. V. M W. Co. and tunnel		0	1,380				1,380	2 11	1,500	100 00	100 00	1 09	109 00	6 54	7 10	None	None	None	0 98	6 12	12 66	6 12	12 66	2 90	6 00
West Redlands Water Co.	Redlands	1902	B. V. M. W. Co.		0	806				806	2 00	806	100 00	125 00	1 00	125 00	7 50	16 00	None	None	None	5 03	10 97	18 47	10 97	18 47	5 49	9 24
California Domestic Water Co.	Whittier	1902	Wells		100	2,000				*2,000	1 60	8,005	50 00	120 00	1.50	180 00	10 80	15 90	None	None	None	2 62	13 28	24 08	13 28	24 08	8 30	15 05
La Habra Water Co.	La Habra	1902	California Domestic Water Co.		100	3,000				*3,000	1 60	5,005	50 00	180 00	1 50	270 00	16 20	24 00	None	None	None	2 62	21 38	37 58	21 38	37 58	13 36	23 49
Canyon Water Co. of Pomona	Pomona	1897	San Antonio River		0	2,500				2,500	1 34	17,280	10 00	15 00	7 00	105 00	6 30	0 70	None	None	None	None	0 70	7 00	0 70	7 00	0 52	5 22
Capistrano Water Co.	Capistrano	1892	San Juan Creek		0	50	350			400	*2 00	421	100 00	100 00	1 00	100 00	6 00	2 50	None	None	None	None	2 50	8 50	2 50	8 50	1 25	4 25
Carmel Water Co.	Montebello	1905	Wells		100	325	20	40	450	835	1 20	3,496	10 00		4 00	40 00	2 40	10 48	None	None	None		10 48	12 88	10 48	12 88	8 73	10 73
Chino Water Co.	Chino	1905	Wells	150	100	50	1,150			1,200	0 56	983	100 00	100 00	1 00	100 00	6 00	None	020	12 10	6 77	None	12 10	18 10	6 77	12 77	12 09	22 80
Citizens Light and Water Co., Bloomington	Bloomington	1907	Wells	100	100	3,825	100	25	50	4,000	1 81	5,197	50 00	250 00	1 00	250 00	15 00	4 50	010	6 05	10 95	None	10 55	25 55	15 45	30 45	8 54	16 82
Covina Irrigating Co.	Covina	1886	San Gabriel River		0	4,500				4,500	1 56	10,000	50 00	100 00	3 00	300 00	18 00	16 50	00208	1 26	1 97	3 33	14 43	32 43	15 14	33 14	9 70	21 23
Cucamonga Water Co.	Cucamonga	1587	Wells; Tunnels	100	19	2,500	700		300	3,500	1 42	4,359	100 00	140 00	1 25	175 00	10 50	17 87	None	None	None	6 41	11 46	21 96	11 46	21 96	8 07	15 46
Del Monte Irrigation Co.	Pomona	1887	Wells	0–340	100	1,800				1,800	2 33	22,600	10 00	20 00	12 55	251 00	15 06	22 60	None	None	None	2 78	19 82	34 88	19 82	34 88	8 51	14 97
Del Norte Water Co.	Ventura	1910	Wells	180–320	100	40	80			600	0 30	2,500	10 00	17 50	1 00	17 50	1 05	0 90	.025	15 13	4 54	None	16 03	17 08	5 44	6 49	18 13	21 63
Dominguez Water Co.	Compton	1910	Wells	30–100	100	x		x	Maj.	12,000	0.53	20,000	50 00	50 00	1 00	50 00	3 00		.0125	7 56	4 01	None	7 56	10 56	4 01	7 01	7 56	13 23
Duarte Mutual Irrigation and Canal Co.	Duarte	1890	San Gabriel River	90		1,200				1,200	1 20	1,259	10 00	500 00	1 00	500 00	30 00	9 00	None	None	None	1 67	7 33	37 33	7 33	37 33	6 11	31 11
Escondido Mutual Water Co.	Escondido	1905	San Luis Rey River		0	1,600			450	2,050	*1.00	222,450	1 00	2 00	150 00	300 00	18 00	7 75	0083	5 02	5 02	1 56	11 21	29 21	11 21	29 21	11 21	29 21
Etiwanda Water Co.	Etiwanda	1882	Tunnels		0	800			1,200	2,000	1 26	2,300	100 00	400 00	1 10	440 00	26 40	3 50	None	None	None	0 60	2 90	29 30	2 90	29 30	2 30	23 24
Fillmore Irrigation Co.	Fillmore	1888	Sespe River	50–100	14	900	250		10	1,160	1 79	2,088	100 00		1 00	100 00	6 00	None			20 00	4 30	15 70	21 70	15 70	21 70	8 77	12 12
Fontana Water Co.	Fontana	1909	Lytle Creek		0	3,820				3,820	*2 08	3,999	100 00	200 00	1 00	200 00	12 00	10 40	None	None	None	2 62	7 78	19 78	7 78	19 78	3 74	9 51
Fruitvale Mutual Water Co.	San Jacinto	1921	San Jacinto River		19	1,144		1,790		2,934	2 08	4,000	100 00	76 00	1 13	85 88	5 15	6 16	0049	2 96	6 16	2 04	7 08	12 23	10 28	15 43	4 95	7 42
Gage Canal Company	Riverside	1884	Santa Ana River, Wells	30	73	6,144				6,144	2 76	12,288	50 00	150 00	2 00	300 00	18 00	None			12 00	1 04	10 96	28 96	10 96	28 96	3 97	10 49
Glendora Con. Mutual Irrigation Co.	Glendora	1920	Wells	450	100	2,050				2,050	1 18	5,040	100 00	90 00	2 30	207 00	12 42	25 30	.040	24 20	28 56	6 21	43 29	55 71	47 65	60 07	40 39	50 91
Hudson Water Co	La Verne	1622	Wells	265	100	75				75	2 39	300	100 00		4 00	400 00	24 00	None	.015	9 08	21 70	None	9 08	33 08	21 70	45 70	9 08	19 12
Irrigation Co. of Pomona	Pomona	1886	Wells	92	100	600	1,300		100	2,000	1 08	24,500	10 00	3 00	10 00	30 00	1 80	20 00	None	None	None	6 50	13 50	15 30	13 50	15 30	12 50	14 60
Imperial Irrigation District (a)	El Centro	1911	Colorado River	0	0													1 80										
Imperial Water Co. No. 1	Imperial	1900	Imperial Irrigation District	0	0	x	x	x	x	121,169	3 00	99,069	10 00	25 00	0 80	20 00	1 20	2 32	00165	1 00	3 00	None	5 12	6 32	7 12	8 32	2 37	2 77
Imperial Water Co. No. 2	Holtville	1913	Imperial Irrigation District	0	0			x	x	6,000	3 00	7,218	10 00	20 00	1 00	20 00	1 20	4 50	00165	1 00	3 00	None	7 30	8 50	9 30	10 50	3 10	3 50
Imperial Water Co. No. 3	Calipatria	1913	Imperial Irrigation District	0	0	155	156	12,000	32,689	45,000	*3 00	48,624	10 00	20 00	0 94	18 80	1 13	2 07	.00140	0 85	2 55	None	4 72	5 85	6 42	7 55	2 14	2 52
Imperial Water Co. No. 4	Brawley	1900	Imperial Irrigation District	0	0			x	x	20,000	3 00	19,801	10 00	15 00	1 00	15 00	0 90	2 20	00165	1 00	3 00	None	5 00	5 90	7 00	7 90	2 33	2 63
Imperial Water Co. No. 5	Holtville	1901	Imperial Irrigation District	0	0			x	x	80,000	*3 30	89,841	10 00	12 50	0 94	11 75	0 70	2 64	00140	0 85	2 81	None	5 19	5 89	7 15	7 85	2 17	2 38
Imperial Water Co. No 6	Calexico	1901	Imperial Irrigation District	0	0			x	x	19,000	3 00	18,984	10 00	12 50	0 94	11 75	0 70	2 59	00165	1 00	3 00	None	5 39	6 09	7 39	8 09	2 46	2 70
Imperial Water Co. No. 7	Holtville	1902	Imperial Irrigation District	0	0			x	x	18,250	*3 00	17,152	10 00	12 50	0 94	11 75	0 70	3 91	.00165	1 00	3 00	None	6 71	7 41	8 71	9 41	2 90	3 14
Imperial Water Co. No. 8	Brawley	1902	Imperial Irrigation District	0	0			x	x	35,000	2 80	43,000	25 00	20 00	0 94	18 80	1 13	2 46	00140	0 85	2 38	None	5 11	6 24	6 64	7 77	2 37	2 77
Imperial Water Co. No. 9	Calipatria	1908	Imperial Irrigation District	0	0			x	x	18,000	3 00	*19,000	10 00	20 00	0 94	18 80	1 13	3 53	None	None	None	None	5 33	6 46	5 33	6 46	1 78	2 15
Imperial Water Co. No. 12	Imperial	1907	Imperial Irrigation District	0	0			x	x	15,000	*3 00	15,400	25 00	25 00	1 00	25 00	1 50	4 50	00165	1 00	3 00	None	7 30	8 80	9 30	10 80	3 10	3 60
Imperial Southside Water Co	Holtville	1912	Imperial Irrigation District	0	0			x	x	18,000	3 00	*18,500	10 00	20 00	1 00	20 00	1 20	4 26	00165	1 00	3 00	None	7 06	8 26	9 06	10 26	3 02	3 42
La Puente Cooperative Water Co.	West Covina	1909	Wells	70	100		1,700		300	2,000	1 35	2,000	50 00	50 00	1 00	50 00	3 00	4 00	.0125	7 56	10 21	2 50	9 06	12 06	11 71	14 71	8 58	10 89
La Verne Water Association	La Verne	1921	Wells	220	100	600				000	*1 63	1,187	100 00	133 00	2 00	266 00	15 96		.0300	18 15	29 58		18 15	34 11	29 58	45 54	18 15	27 94
Lemon Grove Mutual Water Co.	Lemon Grove	1905	Cuyamaca Water Co.		10	x			x	850	0 80	2,190	25 00	25 00	1 60	40 00	2 40	4 00	06035	36 51	29 21		40 51	42 91	33 21	35 61	41 51	44 51
Lugonia Water Co.	Redlands	1887	Santa Ana River		0	2,750	50			2,800	1 20	3,150	100 00	140 00	1 12	156 80	9 40	1 90	None	None	None	None	1 90	11 30	1 90	11 30	1 58	9 42
Lytle Creek Water and Improvement Co	Rialto	1887	Lytle Creek, Wells	50	70	3,000			200	3,200	2 70	3,238	50 00	225 00	1 00	225 00	13 50	8 00	None	None	None	0 31	7 69	21 19	7 69	21 19	2 85	7 85
Moneta Water Co.	Gardena	1916	Wells	90	100		50	45	655	750	2 40	2,050	25 00		3 00	75 00	4 50	None	0147	8 89	12 45	1 42	7 47	11 97	11 03	15 53	7 88	11 09
Montalvo Mutual Water Co.	Ventura	1912	Wells	110	100	240	300		428	968	0 89	980	50 00	100 00	1 00	100 00	6 00	4 60	0125	7 56	6 73	None	12 16	18 16	11 33	17 33	12 73	19 47
Montebello Land and Water Co.	Montebello	1900	Wells	50	100	1,000			200	1,200	0 92	1,250	100 00		1 00	100 00	6 00	12 00	None	None	None	None	12 00	18 00	12 00	18 00	13 05	19 57
Monte Vista Irrigation Co.	Ontario		Wells	250	100	500	100		50	950	1 09	1,000	10 00	100 00	1 00	100 00	6 00	4 00	018	10 89	11 87	4 00	10 89	16 89	11 87	17 87	10 89	16 39
Mound Water Co.	Ventura	1904	Wells		100	240			552	792	0 95	792	100 00	100 00	1 00	100 00	6 00	1 10	0104	6 29	5 98	None	7 39	13 39	7 08	13 08	7 45	13 77
Mutual Land and Water Co.	Rialto	1908	Wells	60	100	500				500	1 70	785	50 00	185 00	1 00	185 00	11 10	13 00	None	None	None	None	13 00	24 10	13 00	24 10	7 65	14 17
North Fork Water Co.	San Bernardino	1885	Santa Ana River		0	1,800				1,800	*2 20	4,800	100 00	120 00	2 50	300 00	18 00	1 50	None	None	None	None	1 50	19 50	1 50	19 50	0 68	8 86
Palo Verde Mutual Water Co.	Blythe	1908	Colorado River		0			6,725	22,409	29,134	*4 30	41,446	10 00	35 00	1 00	35 00	2 10	5 25	None	None	None		5 25	7 35	5 25	7 35	1 22	1 71
Piru Water Co.	Piru	1887	Piru Creek		0	335		20		355	3 60	2,000	10 00	10 00		10 00	0 60	None			8 40	None	8 40	9 00	8 40	9 00	2 33	2 50
Rincon Ditch Co.	Whittier	1913	San Gabriel River		0	150	651	x	x	974	1 60	974	25 00		1 00	25 00	1 50	5 00	None	None	None	None	5 00	6 50	5 00	6 50	3 01	3 91
Riverside Water Co.	Riverside	1885	Santa Ana River		0	1,733	350	3,720	2,255	8,058	2 67	19,271	10 00	75 00	2 00	150 00	9 00	None			8 00	None	8 00	17 00	8 00	17 00	3 00	6 37
San Antonio Irrigation Co.	Downey	1869	Rio Hondo River		0			300	500	800	2 70	8,224	5 00	5 00	8 00	40 00	2 40	3 20	None	None	None	None	3 20	5 60	3 20	5 60	1 19	2 07
San Antonio Water Co.	Ontario	1882	San Antonio River	180	40	5,000				5,000	2 30	6,084	100 00	350 00	1 21	423 50	25 41	11 00	None	None	None	2 00	9 00	34 41	9 00	34 41	3 91	14 96
San Cayetano Mutual Water Co.	Santa Paula	1913	Wells	300	100	400	100			500	1 22	1,231	50 00	57 25	2 00	114 50	6 87	2 50	.03306	20 00	24 40	None	22 50	29 37	26 90	33 77	22 03	27 67
Santa Ana Valley Irrigation Co.	Orange	1877	Santa Ana River	75	25	x	x			17,428	1 69	17,428	5 00	134 49	1 00	134 49	8 07	1 65	0048	2 90	4 90	1 65	2 90	10 97	4 90	12 97	2 90	7 68
San Dimas Water Co.	San Dimas	1894	Wells	200–350		2,200				2,200	1 38	2,200	100 00	200 00	1 00	200 00	12 00	11 60	0214	12 95	17 87	1 36	23 19	35 19	28 11	40 11	20 38	29 78
Saticoy Development Co.	Saticoy	1902	Wells and canyon	165			528			528	1 16	528	40 00	40 00	1 00	40 00	2 40	7 20	0178	10 80	12 53	7 20	10 80	13 20	12 53	14 93	10 80	12 87
South Mountain Water Co.	Redlands	1899	Wells and canyon		50	500				500	2 08	1,000	100 00	100 00	2 00	200 00	12 00	13 00	None	None	None	2 40	10 60	22 60	10 60	22 60	5 10	10 86
South Side Improvement Co.	Fillmore	1887	Santa Clara River, Wells	26	38	1,300	150			1,150	2 50	2,916	10 00	29 50	2 00	59 00	3 54	None	0033	2 00	5 00	None	2 00	5 54	5 00	8 54	2 00	3 42
Standefer Water Co.	Rivera	1902	San Gabriel River		0	900	452			1,352	*1 70	13,525	1 00		10 00	10 00	0 60	0 70	00075	0 45	0 77	None	1 15	1 75	1 47	2 07	0 86	1 22
Sunny Slope Water Co.	Lamanda Park	1895	Wells	153	100	1,400				1,400	0 85	1,400	100 00	125 00	1 00	125 00	7 50	5 50	0168	10 15	8 63	1 18	14 47	21 97	12 95	20 45	15 24	24 05
Temescal Water Co.	Corona	1887	San Jacinto River; Wells	85	50	4,682				4,682	1 65	8,606	100 00	117 50	1 84	216 20	12 97	27 60	None	None	None	6 77	20 83	33 80	20 83	33 80	12 63	20 48
Thermal Belt Water Co.	Santa Paula	1893	Santa Paula Creek; Wells		87	1,275	300			1,575	1 61	1,500	100 00	300 00	1 00	300 00	18 00	7 20	00625	3 78	6 09	1 60	9 38	27 38	11 69	29 69	7 26	18 45
Trabuco Water Co.	Capistrano	1892	Trabuco Creek; Wells	40	38		350			350	2 00	360	100 00	100 00	1 00	100 00	6 00	3 50	None	None	None	None	3 50	9 50	3 50	9 50	1 75	4 75
Walnut Grove Mutual Water Co.	Monrovia	1906	Wells	80	100		x	x	x	781	2 78	781	50 00		1 00	50 00	3 00	2 49	0225	13 61	37 84	2 05	14 05	17 05	38 28	41 28	13 77	14 85
Whittier Extension Mutual Water Co.	North Whittier	1913	Wells	174–418	100	2,000				2,000	0 77	2,500	100 00	200 00	1 00	200 00	12 00	2 40	0325	19 66	15 14	None	22 06	34 06	17 54	29 54	22 78	38 37
Yorba Linda Water Co.	Yorba Linda	1909	Wells	302	100	2,500				2,500	1 14	2,750	100 00	75 00	1 00	75 00	4 50	21 80	None	None	None	3 85	20 95	25 45	20 95	25 45	18 38	22 32
Yucaipa Water Co. No. 1	Yucaipa	1910	Wells; Tunnels	250	60		2,600			2,600	1 16	3,500	100 00	125 00	1.00	125 00	7 50	11 40	0125	7 56	8 77	2 08	16 88	24 38	18 09	25 59	15 60	22 03

*Estimated. x Acreage unknown. (a) Companies absorbed by district late in 1922.

PLATE IV.

FIG. 1. A typical small irrigation pumping plant in Santa Clara Valley.

FIG. 2. Furrow irrigation of a cherry orchard in Santa Clara Valley.

is not c
use of w
Many
The rat
irrigatio
rate bas
of the a
all wate
differen
use, oth
and othe
Mutu
assess th
their ru
when so
ments a
Howe
least on
annual e
ments f
the asse
Where
loans, p
This is
principa

Intere
capital s
stock ha
the redu
tenant t
determi
which r
at 6 per

Duty
factor i
the acre
report r
that is,
be consi

Descr
the ann
water c
There
water t
water a
self expl
Colu
the age
Colu
column

PLATE IV.

FIG. 1. A typical small irrigation pumping plant in Santa Clara Valley.

FIG. 2. Furrow irrigation of a cherry orchard in Santa Clara Valley.

number shares per acre." Where market value is not obtainable the par value is used.

Column 24, "Water charge per acre for the average amount used" is equal to column 22, "Water rate" where the water rate is on the basis of a flat charge per acre. Where a measured rate is used it is equal to column 23, "Water rate per acre-foot" multiplied by column 14, "Average duty of water per acre at delivery gate."

The last six columns of the table are the final results obtained from the previous columns, and show the annual cost of water. Columns 26, 28 and 30 exclude interest on value of capital stock while columns 27, 29 and 31 include the interest.

Columns 26 and 27 showing the "Annual cost of water per acre for first acre-foot" were included in the table mainly for comparison purposes; they show what the cost would be if the irrigator only used one acre-foot instead of the average amount used by the system. Hence where the charge is on the per-acre basis an irrigator using one acre-foot pays just as much as the irrigator who uses three acre-feet. On the other hand, if the water charge is on a measured basis the water user pays according to the amount used. Column 26 is equal to column 21 plus column 24, minus column 25, if the flat rate per acre is the basis of the water charges. When the measured rate is used column 26 is equal to column 21 plus column 23 minus column 25. Column 27 is equal to column 26 plus column 20.

Columns 28 and 29 show the "Cost of water per acre for average amount used." Column 28 is equal to column 21 plus column 24 minus column 25. Column 29 is equal to column 28 plus column 20.

Columns 30 and 31 show the "Cost of water per acre foot for average amount used." Column 30 is equal to column 28 divided by column 14. Column 31 is equal to column 29 divided by column 14.

Table 18, showing annual cost of water to irrigators under principal mutual water companies in southern California, is similar to Table 17 except that, there being fewer column headings, they are numbered differently.

As was the case with irrigation districts, the many variable conditions which affect the annual cost of water under different mutual companies make fair comparisons difficult.

The method used in arriving at the cost of water under mutual water companies has been to take into account the assessment on the capital stock, the charge for water delivered, and the interest on capital stock. The entire cost is included in these items, with the exception of depreciation on the plant, which has not been considered because it was not practical to include in this study the vast amount of work necessary fairly to determine depreciation under each of the many systems. No doubt in many cases repairs of a permanent nature offset this factor.

From the sum of the above three items considered should be deducted the amount put into a sinking fund to retire bonds or loans. Interest paid on the principal is properly chargeable to the annual cost of water, while funds collected to retire the principal of indebtedness are not, and should be charged to capital account. Many irrigators overlook the fact that funds invested in water stock would earn interest if loaned out, and that such interest should be charged to their annual cost of irrigation water.

Of the items that make the total annual cost of water the assessments and interest on capital stock are fixed charges because they relate to a share of stock and must be paid whether any water is used or not; but water charge or rate varies in many cases according to the amount of water used by the stockholders. For these reasons and others, together with the fact that the duty of water per acre is not uniform, the matter of fairly comparing the annual cost of water under different mutual companies is complex. To compare the costs "per acre" is objectionable where the duty varies. In cases where the cost per acre is the summation of fixed and variable charges it is unsatisfactory to compare the costs "per acre-foot," as this is obtainined by dividing the cost per acre by the duty of water in acre-feet.

Notwithstanding the complications which arise when comparing the costs under different systems, some idea may be given as to the variations in the annual cost of water to the irrigators throughout the state, and under different conditions, by the following summaries of tables 17 and 18.

Duty of water—Table 19 is a summary of tables 17 and 18, showing the minimum and maximum duty of water under mutual companies in northern, central, and southern California, and for the state as a whole. The number of companies considered is shown in the table.

TABLE 19—SUMMARY OF DUTY OF WATER UNDER MUTUAL WATER COMPANIES.

Section of California	Number of companies considered	Quantity of water used per acre	
		Minimum, acre-feet	Maximum, acre-feet
Northern	9	0.86	5.94
Central	26	.43	4.00
Southern	78	.30	4.30
Entire state	113	.30	5.94

The minimum duty of water of 0.86 acre-foot per acre for northern California as shown in Table 19 is for a system irrigating deciduous fruits, beans, truck, and alfalfa. All the water is pumped from the Sacramento River through an average lift of 24 feet. The minimum duty of water for Central California of 0.43 acre-foot per acre is for an enterprise growing deciduous fruits entirely, at an elevation of about 4000 feet. All the water is pumped through average lift of 70 feet. The minimum duty of water for southern California of 0.30 acre-foot per acre is for a system under which the crop is almost entirely beans, which receive only one irrigation per season. All the water is pumped with lifts ranging from 180 to 320 feet.

The maximum duty of water of 5.94 acre-feet per acre as shown in Table 19 for northern California is for rice. All the water is pumped under this system at a lift of about 8 feet. In central California the maximum duty of water of 4.00 acre-feet per acre is for a new project having sandy soil and a large acreage of alfalfa. Fifty per cent of the water is pumped through an average lift of 30 feet. The maximum duty of water of 4.30 acre-feet per acre for southern California is found under a system in Palo Verde Valley irrigating alfalfa and cotton through the

long hot and dry season of the Colorado Desert. This is all gravity water taken from the Colorado River.

Annual cost of irrigation water—Table 20 is a summary of tables 17 and 18, showing minimum and maximum costs of irrigation water under mutual water companies in northern, central and southern California and for the state as a whole. The number of companies considered in obtaining the average is also shown in the table.

TABLE 20—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL WATER COMPANIES.

Section of California	Number of companies considered	Annual cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	9	$1 84	$13 67	$0 55	$7 82
Central	24	83	36 17	40	27 44
Southern	78	2 07	60 07	1 22	50 91
Entire state	111	83	60 07	40	50 91

The cheapest water is supplied by the older gravity systems, some of which were constructed in the early fifties. Some are capitalized at a few dollars per acre, which does not represent the true present value of the water. In the absence of proper basis for interest charges the main expense under them consists of fees paid to the zanjeros, and in a few instances the farmers do most of the work themselves.

The lowest cost per acre is for a system using 1.68 acre-feet of water per acre. This cost per acre is made up of interest, $0.17, and an average annual assessment of $0.83, from which is deducted $0.17 for sinking fund, leaving a total cost per acre of $0.83. The lowest cost of $0.40 per acre-foot is for a company having the following items of cost per acre for water: interest $0.41 and average assessment of $0.71, from which is deducted $0.20 for sinking fund, leaving a total per acre cost of $0.92. This divided by the duty of water of 2.30 acre-feet per acre for the system gives a cost of $0.40 per acre-foot.

For the entire state, the highest costs are found under systems which pump all their water, although there are some gravity systems in southern California that have higher costs than many pumping systems.

The maximum costs of $60.07 per acre and $50.91 per acre-foot are found under a system in southern California lifting water about 450 feet from wells and having a duty of 1.18 acre-feet per acre. The cost per acre is made up of the following items: interest $12.42, average annual assessment $25.30, and water charge $28.56, from which is deducted $6.21 for sinking fund, making a total cost of $60.07 per acre. This cost divided by the duty of water of 1.18 acre-feet per acre gives a cost per acre-foot of $50.91.

Annual cost of gravity water—Table 21 is a summary of tables 17 and 18 showing minimum and maximum annual costs of water under mutual companies delivering all gravity water. Figures are shown for northern, central, and southern California, and for the state as a whole. They include interest on value of capital stock.

TABLE 21 SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES DELIVERING ALL GRAVITY WATER.

Section of California	Number of companies considered	Cost of water including interest on capital invested			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	5	$1 84	$6 50	$0 55	$3 48
Central	16	83	4 40	40	2 20
Southern	34	2 07	33 14	1 22	29 21
Entire state	55	83	33 14	40	29 21

The lowest costs have already been analyzed in detail under "annual cost of irrigation water." The highest costs for gravity water are found in southern California; the maximum is $33.12 per acre. This cost is mainly due to the fact that this system has to keep up a pumping plant for protection against dry years, as well as to the high value of water rights. However, no water was pumped for the year the data refers to. The items making up the annual cost per acre are as follows: interest $18.00, average assessment $16.50, and water charge $1.97, from which is deducted $3.33 for sinking fund, making a total cost of $33.14 per acre. The duty of water is 1.56 acre-feet per acre and 4500 acres of citrus trees are irrigated.

The highest cost of $29.21 per acre-foot is under a company bringing water some distance from a storage reservoir. The cost items per acre are as follows: interest $18.00, average assessment $7.75, and water charge $5.02, from which is deducted $1.56, making a total cost of $29.21 per acre. The cost per acre-foot of water is $29.21, the duty of water being 1.00 per acre-foot per acre.

Annual cost of pumped water—Table 22 is a summary of tables 17 and 18 showing the minimum and maximum annual costs of water under mutual companies delivering all pumped water. Figures are shown for northern, central, and southern California, and for the state as a whole. They include interest on value of capital stock.

TABLE 22—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES DELIVERING ALL PUMPED WATER.

Section of California	Number of companies considered	Cost of water including interest on value of capital stock			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Northern	4	$5 86	$13 67	$2 41	$7 82
Central	7	6 47	36 17	4 03	27 44
Southern	24	6 49	60 07	10 73	50 91
Entire state	35	5 86	60 07	2 41	50 91

Table 22 indicates that the lowest cost per acre and per acre-foot for "all pumped water" is found in northern California, while the highest cost is under a system in southern California.

The minimum cost of $5.86 per acre is accounted for by the fact that the system concerned has a duty of only 0.86 acre-foot per acre, and pumps water from the Sacramento River through the low lift of 24 feet. The minimum cost of $2.44 per acre-foot is for a company buying water from another system and pumping 8 feet from a canal. This cost is for a rice crop which uses 5.60 acre-feet of water per acre. Incidently, because of the large amount of water used, this system has the highest cost per acre in northern California, $13.67.

The highest cost of $60.07 per acre and $50.91 per acre-foot are found under a company in southern California. The lift is about 450 feet and the amount of water used is 1.18 acre-feet per acre. The items making up these costs have already been discussed.

Cost of water for various crops—For mutual water companies furnishing water for several crops and with fixed water charges such as assessments or a flat rate per acre it is difficult to make fair comparisons of the cost of water for different crops. There are many companies, however, especially in southern California, which deliver practically all their water to one crop.

The following summaries of tables 17 and 18 indicate the variation in costs for citrus trees, deciduous trees and vines, alfalfa and rice, for northern, central, southern California, and the state as a whole. The number of companies considered is shown in each table.

TABLE 23—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES IN NORTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on value of capital stock			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	2	$1 84	$6 50	$0 55	$3 39
Deciduous trees and vines	9	1 84	7 82	55	7 82
Alfalfa	8	1 84	7 82	55	7 82
Rice	3	2 88	13 67	96	2 44

TABLE 24—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES IN CENTRAL CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on value of capital stock			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	3	$4 77	$36 17	$1 08	$10 33
Deciduous trees and vines	24	83	36 17	40	27 44
Alfalfa	16	83	7 60	40	4 84
Rice	None				

PLATE V.

FIG. 1. Basin irrigation of a prune orchard.

FIG. 2. Dam across San Joaquin River at head of San Joaquin and Kings River Canal.

TABLE 25—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES IN SOUTHERN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on value of capital stock			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	59	$2 07	$60 07	$1 22	$50 91
Deciduous trees and vines	32	2 07	41 28	1 22	27 67
Alfalfa	22	5 60	41 28	1 71	16 82
Rice	None				

TABLE 26—SUMMARY OF ANNUAL COST OF WATER UNDER MUTUAL COMPANIES IN CALIFORNIA FOR VARIOUS CROPS.

Crop	Number of companies considered	Cost of water including interest on value of capital stock			
		Per acre		Per acre-foot	
		Minimum	Maximum	Minimum	Maximum
Citrus trees	64	$1 84	$60 07	$0 55	$50 91
Deciduous trees and vines	65	83	41 28	40	27 67
Alfalfa	46	83	41 28	40	16 82
Rice	3	2 88	13 67	96	2 44

PRIVATE PUMPING PLANTS.

Introduction—The United States census of 1920 reported 21,561 irrigation pumping plants in California; the present number is doubtless more than 25,000. Most of these plants are owned and operated by individual farmers, although some of the other types of irrigation enterprises depend entirely on pumped water for irrigation. The Census reported 826,846 acres of land irrigated by pumping from wells in 1919, and this acreage has increased materially since that date.

The average farmer keeps very few pumping plant records. For this reason it was necessary to test each plant before any reliable data could be ascertained on cost of pumping water for irrigation. It is obvious that one field party could spend several years determining such cost data, and then cover only a small percentage of the plants in the state; hence only private pumping plants considered representative were tested in a few sections of the state which had not already been fully covered in the surveys of other types of irrigation enterprises. C. N. Johnston, Division of Irrigation Investigations and Practice, University of California, conducted the field tests to ascertain cost of pumping for year 1922 in Sacramento Valley, while Milo B. Williams and W. B. Maher made similar tests in Santa Clara, San Joaquin and other valleys for the 1923 season.

FACTORS IN COST OF PUMPING UNDER PRIVATE PUMPING PLANTS.

Many irrigators, when figuring the cost of pumping water, are likely to consider only the actual operating expenses of a plant; but the cost of

irrigation by pumping properly includes the cost of fuel or power attendance and all fixed charges.

Cost of power—Most power companies supplying electrical energy for use in irrigation pumping have an annual demand or minimum charge per horsepower in addition to an energy charge. The annual power bills for the plants tested were obtained from the companies, but in many cases it was impracticable to separate the demand or minimum charges from the energy charge. Accordingly this segregation will not be attempted in the statements which follow. The power rates vary with different companies, as indicated in the schedules:

TABLE 27. POWER SCHEDULES FOR PUMPING, SACRAMENTO VALLEY, 1922.

Pacific Gas and Electric Company.

Rate

(a) For installations of less than 50 horsepower:

First	500 k.w.h. per meter per month	3.2 cents per k.w.h.
Next	500 k.w.h. per meter per month	2.7 cents per k.w.h.
Next	2,000 k.w.h. per meter per month	2.2 cents per k.w.h.
All over	3,000 k.w.h. per meter per month	1.7 cents per k.w.h.

Minimum charge: $7 per horsepower per year, but not less than $30 per year.

(b) For installation of 30 horsepower and over:

Size of installation—	Rate per k.w.h.	Annual minimum charge per h.p.
30 to 49 h.p.	2.2 cents	$7 00
50 to 99 h.p.	1.7 cents	7 00
100 h.p. and over	1.5 cents	7 00
100 to 499 h.p.	1.2 cents	14 00

Surcharge: 6 per cent in addition to the above charges.

TABLE 28. POWER SCHEDULES FOR PUMPING PLANTS TESTED IN 1923.

Pacific Gas and Electric Company.

Territory, Santa Clara Valley and Modesto.

Rate A.

Size of installations	Annual demand charge per h.p.	Energy charge in addition to the demand charge; rate per k.w.h. for consumption per h.p. per year of—			
		First 1000 k.w.h.	Next 1000 k.w.h.	Next 1000 k.w.h.	All over 3000 k.w.h.
2 to 4 h.p.	[1]$6 60	1.6 cents	1.2 cents	0.9 cent	0.7 cent
5 to 14 h.p.	6 00	1.4 cents	1.1 cents	.8 cent	.7 cent
15 to 49 h.p.	5 40	1.2 cents	1.0 cent	.8 cent	.7 cent
50 to 99 h.p.	4 50	1.1 cents	.9 cent	.75 cent	.7 cent
100 to 249 h.p.	3 90	1.1 cents	.9 cent	.75 cent	.7 cent

[1]In no case will the total annual demand be less than $13.20.

Rate B. Optional Rate.

Any consumer may select at his option the following rate instead of the demand and energy rate set forth above.

Horsepower of connected load	Annual minimum charge per h.p.	Rate per k.w.h. for consumption per h.p. per year of—				
		First 300 k.w.h.	Next 700 k.w.h.	Next 1000 k.w.h.	Next 1000 k.w.h.	All over 3000 k.w.h.
2 to 4	[2]$9 00	3.8 cents	1.6 cents	1.2 cents	0.9 cent	0.7 cent
5 to 14	8 00	3.4 cents	1.4 cents	1.1 cents	.8 cent	.7 cent
15 to 49	7 50	3.0 cents	1.2 cents	1.0 cent	.8 cent	.7 cent
50 to 99	7 00	2.6 cents	1.1 cents	.9 cent	.75 cent	.7 cent
100 to 249	6 75	2.4 cents	1.1 cents	.9 cent	.75 cent	.7 cent

[2]In no case will the total minimum charge be less than $27 per year.

Coast Counties Gas and Electric Company.

Territory, Morgan Hill, San Martin, Gilroy, Watsonville, Chualar.

Rate:

Demand charge	Gross	Net
For the first 5 h.p. of connected load	$8 60	$8.00 per h.p. per year
For the next 45 h.p. of connected load	6 30	6.00 per h.p. per year
For all over 50 h.p. of connected load	4 00	4.00 per h.p. per year

Energy charge	Gross	Net
For the first 3,000 k.w.h. per year	2.10 cents	2.00 cents per k.w.h.
For the next 27,000 k.w.h. per year	1.60 cents	1.50 cents per k.w.h.
For all over 30,000 k.w.h. per year	1.35 cents	1.25 cents per k.w.h.

Total charge: The total charge is the sum of the demand and energy charges.

The net rate is effective if the bill is paid on or before the 15th of the month next succeeding that for which the bill is rendered.

If the bill is not paid on or before the 15th, the gross charge is effective.

San Joaquin Light and Power Corporation.

Territory, Chowchilla, McFarland.

Rate:

Size of plant—	Annual demand charge
2 to 4 h.p.	$16 00 per h.p. per year
5 to 14 h.p.	14 00 per h.p. per year
15 to 49 h.p.	13 00 per h.p. per year
50 to 99 h.p.	12 00 per h.p. per year
100 h.p. and over	11 00 per h.p. per year

Energy charge.

First 1000 k.w.h. per year	0.9 cent per k.w.h.
Next 1000 k.w.h. per year	.8 cent per k.w.h.
Next 1000 k.w.h. per year	.7 cent per k.w.h.
Next 2000 k.w.h. per year	.6 cent per k.w.h.
All over 5000 k.w.h. per year	.5 cent per k.w.h.

Optional Rate:

Annual consumption per horsepower	Rate per k.w.h. for connected loads of—		
	15 to 49 h.p.	50 to 99 h.p.	100 h.p. or over
First 500 k.w.h.	2.6 cents	2.4 cents	2.3 cents
Next 500 k.w.h.	1.8 cents	1.8 cents	1.7 cents
Next 1000 k.w.h.	.8 cent	.8 cent	.8 cent
Next 1000 k.w.h.	.7 cent	.7 cent	.7 cent
Next 2000 k.w.h.	.6 cent	.6 cent	.6 cent
All over 5000 k.w.h.	.5 cent	.5 cent	.5 cent

Minimum charge: First 10 h.p. at $15 per h.p. per year, but not under $30 per year. All over 10 h.p. at $12 per h.p. per year.

Southern California Edison Company.

Territory, Visalia, Exeter, Lemon Cove, Lindsay, Porterville, Tulare.

Rate:

Annual consumption per horsepower	Rate per k.w.h. for connected load—				
	1 to 4 h.p.	5 to 14 h.p.	15 to 49 h.p.	50 to 99 h.p.	100 h.p. or over
First 1000 k.w.h.	2.7 cents	2.5 cents	2.3 cents	2.2 cents	2.1 cents
All over 1000 k.w.h.	.9 cent	.9 cent	.9 cent	.9 cent	.9 cent

Minimum charge: First 10 h.p., $15 per horsepower per year but not less than $30. All over 10 h.p. $12 per horsepower per year.

Discount: Above rates excepting minimum charge are subject to 10 per cent discount.

Optional Rate:

Size of installation	Annual charge per h.p.	Additional energy rate per k.w.h.
1 to 4 h.p.	$18 00	0.9 cent
5 to 14 h.p.	16 00	.9 cent
15 to 49 h.p.	14 00	.9 cent
50 to 99 h.p.	13 00	.9 cent
100 h.p. and over	12 00	.9 cent

Ten per cent discount on above rates.

Cost of fuel oil—A few engine-driven plants included in the tests used for fuel distillate costing 12 cents per gallon.

Attendance—Many farmers do not consider the expense of attendance as part of the cost of operating a plant as they spend at odd moments the time necessary. Such time should be charged to the annual cost of water just as though the irrigator had hired the work done. The attendance charge for distillate plants will vary somewhat depending upon the type and size. Motor-driven plants require very little attendance and for the purpose of comparing costs this item will be taken as 4 cents per hour of operation.

Fixed charges—Interest on capital invested, taxes, insurance, depreciation, renewals, maintenance, and repairs may be considered as representing fixed charges and properly included in the annual cost. The cost of a complete pumping plant, including motor or engine, pump, well and casing, installation, and other items, represents a capital which if invested in reliable securities would produce an interest income. Information on the cost of a plant can usually be obtained from the owner, but very seldom the other fixed charges. Some farmers carry no insurance on their plant and keep no records of renewals, maintenance and repairs. There may be considerable variation in the fixed charges depending upon the rate of interest, type of plant, and care of machinery. For estimating them, a uniform percentage of total cost of plant was used throughout, in order to make possible a comparison of various plants tested. These figures are shown in Table 29. It is believed they represent average pumping plant conditions.

TABLE 29—ESTIMATED FIXED CHARGES FOR PUMPING PLANTS.

	Electric plants	Distillate plants
Interest	6 per cent	6 per cent
Taxes and insurance	1 per cent	1 per cent
Repairs and maintenance	1 per cent	3 per cent
Depreciation and renewals	7 per cent	10 per cent
Totals	15 per cent	20 per cent

PUMPING PLANT TESTS.

Discharge—Wherever possible the quantity of water being lifted by the pump was measured by a portable steel weir either of the rectangular or the 90-degree triangular notch type. The discharge was determined

from standard weir tables, In some cases the "color method"* was used in measuring the discharge.

Lift—The working head was determined by use of pressure and vacuum gages for some plants, while in other cases it was measured directly with an electric sounding line especially designed for the purpose.

Power—The number of kilowatts consumed per hour by the electrical plants was computed from the speed of the meter disk and the meter constant. The disk was timed by a stop watch.

Plant efficiency—The plant efficiency was computed from the measurements made of discharge, lift, and power input. For the electric plants it is the ratio of the water horsepower to the electrical horsepower input at the motor.

Description of plants—It was not the purpose of this investigation to make complete mechanical tests of pumping plants and for this reason measurements not essential in determining the cost of pumping were omitted. Each plant tested is described briefly below:

Plant 1.

Location—Two miles north of Dixon on highway.

Plant—10-horsepower General Electric motor; direct-connected to a 5-inch Krogh centrifugal pump. Pit 29 feet deep.

Cost—Complete plant $1100.

Remarks—In 1922 plant operated 570 hours and pumped 31.9 acre-feet of water. Efficiency of plant estimated at 42.3 per cent.

Plant 2.

Location—Eight miles north of Dixon.

Plant—15-horsepower General Electric motor; direct-connected to a No. 6 Krogh, Type B, pump.

Cost—Complete plant $750.

Remarks—In 1922 plant operated 955 hours and pumped 139.5 acre-feet of water from Putah Creek. Plant efficiency estimated at 60 per cent.

Plant 3.

Location—Two miles from Dixon on highway.

Plant—7½-horsepower General Electric motor; direct-connected to a 4-inch Krogh pump in pit.

Cost—Complete plant $800.

Remarks—In 1922 plant operated 561 hours and pumped 15.15 acre-feet of water. Plant almost worn out. Plant efficiency estimated at 22 per cent.

Plant 4.

Location—One and one-half miles north of Dixon.

Plant—10-horsepower General Electric motor; direct-connected in pit to No. 6 Krogh centrifugal pump.

Cost—Complete plant $1000.

Remarks—Plant operated 1215 hours and pumped 88.8 acre-feet of water in 1922. Estimated plant efficiency 18.5 per cent.

*The Flow of Water in Concrete Pipe, by Fred C. Scobey, Bulletin 852, U. S. D. A., page 18.

PLATE VI.

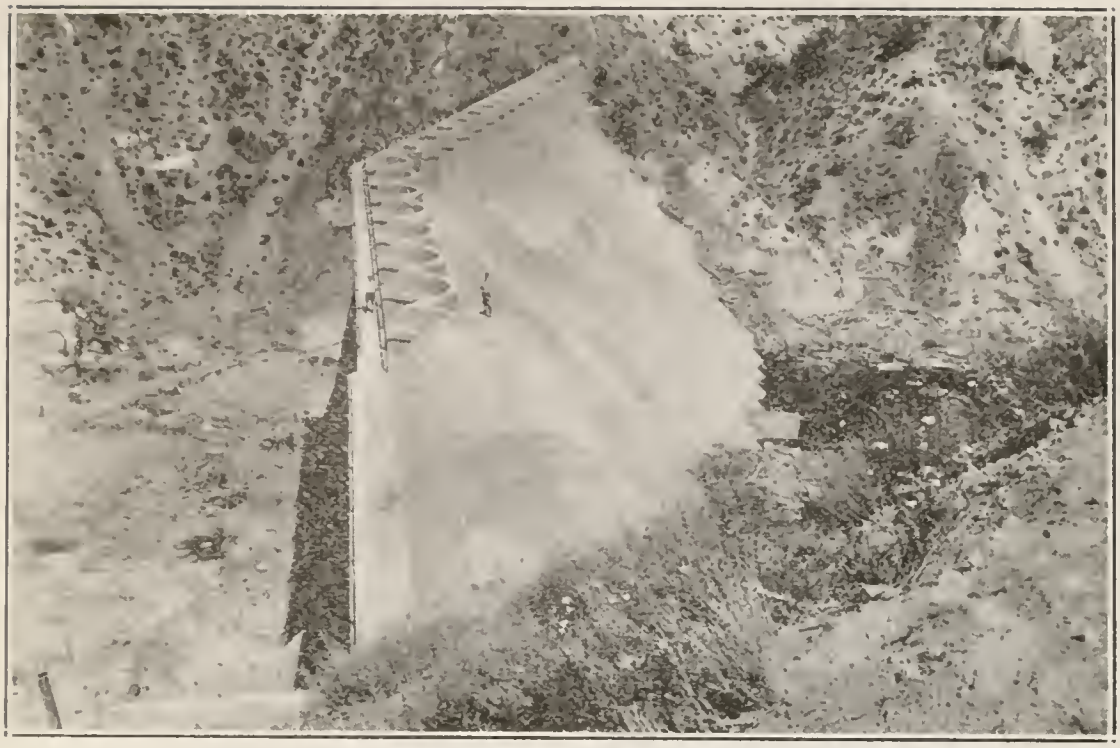

FIG. 1. Newly-built storage dam of Palmdale and Littlerock Irrigation Districts.

FIG. 2. Below San Dimas Wash—an unusually prolific underground water-bearing area tapped by many irrigation pumping plants.

Plant 5.

Location—One and one-half miles north of Dixon.

Plant—30-horsepower Wagner motor; direct-connected to 7-inch Krogh centrifugal pump.

Cost—Complete plant $1500.

Remarks—In 1922 plant operated 1366 hours and pumped 258.3 acre-feet of water. Plant efficiency estimated at 42.5 per cent.

Plant 6.

Location—Two miles northwest of Dixon.

Plant—35-horsepower General Electric horizontal motor; direct-connected to a No. 8-B Krogh pump in pit 25 feet deep.

Cost—Complete plant $2450.

Remarks—In 1922 plant operated 1710 hours and pumped 342 acre-feet of water. Plant efficiency estimated at 42 per cent.

Plant 7.

Location—Two and one-half miles northeast of Dixon.

Plant—25-horsepower Western Electric motor; connected to Layne-Bowler 12-inch turbine pump.

Cost—Complete plant $2450.

Remarks—In 1922 plant operated 1246 hours and pumped 198 acre-feet of water. Efficiency of plant estimated at 37 per cent.

Plant 8.

Location—One and one-half miles northeast of Dixon.

Plant—50-horsepower Westinghouse motor; belt-connected to a 12-inch Layne-Bowler turbine pump.

Cost—Complete plant $2450.

Remarks—In 1922 plant operated 1740 hours and pumped 365 acre-feet of water. Plant efficiency estimated at 34.6 per cent.

Plant 9.

Location—Near Dixon, Solano County.

Plant—25-horsepower Western Electric motor; belt-connected to a 12-inch Layne-Bowler turbine pump.

Cost—Complete plant $2450.

Remarks—In 1922 plant operated 925 hours and pumped 149-acre-feet of water. Efficiency of plant estimated at 32 per cent.

Plant 10.

Location—One and one half miles northeast of Dixon.

Plant—15-horsepower General Electric motor; direct-connected to a 6-inch Byron-Jackson centrifugal pump.

Cost—Complete plang $1000.

Remarks—In 1922 plant operated 920 hours and pumped 60.7 acre-feet of water. Efficiency of plant estimated at 29.7 per cent.

Plant 11.

Location—Two and one-half miles northeast of Dixon and one mile from highway.

Plant—10-horsepower Fort Wayne motor; direct-connected to a 5-inch centrifugal Price pump.

Cost—Complete plant $1235.

Remarks—In 1922 plant operated 631 hours and pumped 59.6 acre-feet of water. Plant efficiency estimated at 52.6 per cent.

Plant 12.

Location—Two miles northeast of Dixon.

Plant—25-horsepower General Electric motor; connected to a 12-inch Layne-Bowler turbine pump.

Cost—Complete plant $2450.

Remarks—Estimated that plant operated 499 hours and pumped 84.9 acre-feet of water in 1922. Efficiency of plant eltimated 39.5 per cent.

Plant 13.

Location—One mile north of Dixon, just east of highway.

Plant—10-horsepower rebuilt motor; direct-connected to a 5-inch Krogh pump.

Cost—Complete plant $800.

Remarks—Plant operated 2417 hours and pumped 221.3 acre-feet of water in 1922. Efficiency of plant estimated at 39 per cent.

Plant 14.

Location—University farm at Davis.

Plant—35-horsepower General Electric motor; vertical direct-connected to a 12-inch Byron-Jackson turbine pump in a 14-foot pit.

Cost—Motor, $600; pump, $1200; well and casing, $640; installition, $100; additional items, $150; complete plant $2690.

Remarks—In 1922 plant operated 608 hours and pumped 56.29 acre-feet of water. About 44.14 acre-feet was used for irrigation on 15 acres of alfalfa and 12 acres of orchard.

Plant 15.

Location—Three-fourths mile west of Davis.

Plant—25-horsepower General Electric vertical motor; direct-connected to a 12-inch Layne-Bowler deep well turbine pump.

Cost—Motor, $756; pump, $1300; well and casing, $1300; installation, $200; complete plant $3556.

Remarks—In 1922 plant operated 213 hours and pumped 12.6 acre-feet of water. Efficiency of plant estimated at 15.2 per cent.

Plant 16.

Location—Three and one-half miles east of Davis on south side of highway.

Plant—10-horsepower Fairbanks-Morse motor; belt-connected to a 5-inch Byron-Jackson centrifugal pump in pit.

Cost—Complete plant $1000.

Remarks—In 1922 plant operated 362 hours and pumped 44 acre-feet of water. Plant efficiency estimated at 62 per cent.

Plant 17.

Location—Two miles east of Davis on highway.

Plant—20-horsepower Fairbanks-Morse motor; belt-connected to a 12-inch Layne-Bowler pump.

Cost—Complete plant $2500.

Remarks—In 1922 plant operated 404 hours and pumped 28.7 acre-feet of water. About half the pumping was to eliminate sand. Efficiency of plant estimated at 15.4 per cent.

Plant 18.

Location—Three miles east of Davis and north of highway.

Plant—20-horsepower Fairbanks-Morse vertical motor; direct-connected to a 12-inch Layne-Bowler turbine pump.

Cost—Motor, $625; pump, $1100; well and casing, $500; complete plant $2225.

Remarks—In 1922 plant operated 319 hours and pumped 33.5 acre-feet of water. Efficiency of plant estimated at 46.8 per cent.

Plant 19.

Location—Two miles east of Davis on a road one mile north of highway.

Plant—20-horsepower General Electric motor; belt-connected to a 12-inch Layne-Bowler turbine pump.

Cost—Complete plant $1100.

Remarks—In 1922 plant operated 344 hours and pumped 23.3 acre-feet of water. Plant efficiency estimated at 25 per cent.

Plant 20.

Location—University farm at Davis.

Plant—25-horsepower General Electric vertical motor; direct-connected to a 12-inch Byron-Jackson turbine pump.

Cost—Motor, $450; pump, $1440; well and casing, $500; installation, $200; complete plant $2590.

Remarks—In 1922 plant operated 627 hours and pumped 62.84 acre-feet of water. Efficiency of plant estimated at 56 per cent.

Plant 21.

Location—Two and one-half miles from Woodland on Knights Landing highway.

Plant—100-horsepower General Electric motor; belt-connected to a 12-inch Byron-Jackson centrifugal pump in pit.

Cost—Complete plant $12,000.

Remarks—In 1922 plant operated 1194 hours and pumped 830 acre-feet of water. Efficiency of plant estimated at 25.1 per cent.

Plant 22.

Location—Three miles east of Winters on highway.

Plant—40-horsepower Wagner motor; connected to an 8-inch United Iron Works horizontal centrifugal pump.

Cost—Complete plant $3000.

Remarks—In 1922 plant operated 597 hours and pumped 178 acre-feet of water. Efficiency of plant estimated at 50 per cent.

Plant 23.

Location—Two miles east of Winters on highway.

Plant—16-horsepower Rawleigh Schryer single-cylinder horizontal distillate engine; belt-connected to a 6-inch horizontal American pump in pit.

Cost—Complete plant $2000.

Remarks—In 1922 plant operated 453 hours and pumped 70.4 acre-feet of water. Used 1½ gallons of distillate per hour at 12 cents a gallon. Efficiency of plant estimated at 37 per cent.

Plant 24.

Location—One and one-half miles east of Winters on highway.

Plant—20 horsepower Fordson tractor blocked in place; belt-connected to a 5-inch Byron Jackson vertical shaft centrifugal pump.

Cost—Engine, $450; pump, $400; well and casing, $400; complete plant $1250.

Remarks—In 1922 plant operated 750 hours and pumped 76.5 acre-feet of water. Used 1.7 gallons of distillate per hour at 12 cents per gallon. Efficiency of plant estimated at 32 per cent.

Plant 25.

Location—Two and one-half miles south of Woodland.

Plant—65-horsepower rebuilt marine engine; belt-connected to a 12-inch Price centrifugal pump. Suction line to six 12-inch wells.

Cost—Engine, $3500; pump, $1500; wells and casings, $4000; installation, $4500; complete plant $13500.

Remarks—In 1922 plant operated 504 hours and pumped 356 acre-feet of water. Used 6½ gallons of distillate per hour at 12 cents per gallon. Attendance charge 40 cents per hour operation. With load on pump engine almost idling. Assuming 50-horsepower from engine, efficiency of plant estimated at 48 per cent.

Plant 26.

Location—Eight miles south of San Jose at Edenvale Station on highway.

Plant—30 horse-power Western Electric motor; connected to a 5-inch Byron Jackson vertical centrifugal pump set in a 18 by 6 by 8 feet wooden pit.

Cost—Complete plant $1500.

Remarks—In 1923 plant operated 820 hours and pumped 134 acre-feet of water. Efficiency of plant estimated at 38.9 per cent.

Plant 27.

Location—Five and one-half miles south of San Jose.

Plant—15-horsepower Fairbanks Morse motor; connected to a No. 5 Byron Jackson centrifugal pump in 8 by 8 by 45 feet wooden pit. Two wells.

Cost—Motor and pump, $900; well and casing, $270; installation $100; complete plant $1370.

Remarks—In 1923 plant operated 363 hours and pumped 34 acre-feet of water. Plant efficiency estimated at 34 per cent.

Plant 28.

Location—On highway south of San Jose.

Plant—30-horsepower Westinghouse motor; connected to an 8-inch vertical centrifugal pump in 6 by 6 by 24 feet pit. Two wells 6 feet apart.

Cost—Motor and pump, $1800; well and casing, $1200; additional items, $300; completed plant $3300.

Remarks—In 1923 plant operated 454 hours and pumped 106.6 acre-feet of water. Efficiency of plant estimated at 53.3 per cent.

Plant 29.

Location—Almaden, two miles northeast of Los Gatos road.

Plant—20-horsepower Westinghouse motor; connected to a No. 4 Krogh vertical centrifugal pump in pit 52 feet deep.

Cost—Complete plant estimated at $2000.

Remarks—In 1923 plant operated 937 hours and pumped 37.8 acre-feet of water. Estimated plant efficiency 35.3 per cent.

Plant 30.

Location—One mile northwest of Santa Clara.

Plant—40-horsepower General Electric motor; connected to a Byron Jackson pump.

Cost—Motor, $1000; pump, $2230; well and casing, $3305; complete plant, $6535.

Remarks—In 1923 operated 638 hours and pumped 169.6 acre-feet of water. Estimated plant efficiency 57.5 per cent.

Plant 31.

Location—One mile west of San Jose on Los Gatos road.

Plant—50-horsepower motor; connected to a 6-inch Krogh vertical turbine pump, set in 12-foot circular pit 46 feet deep. Top suction draws from three 10-inch wells.

Cost—Motor, $850; pump, $1200; wells and casings, $1500; pit, $2500; belt, $150; house, $200; complete plant, $6400.

Remarks—In 1923 plant operated 997 hours and pumped 106.8 acre-feet of water for irrigation. This represents 94 per cent of time operated, as the plant was also used for cannery. Estimated plant efficiency 23.7 per cent.

Plant 32.

Location—Two and one-half miles north of Mountain View on highway.

Plant—20-horsepower Robbins-Meyers motor; belt-connected to a 10-inch Western deep well turbine pump.

Cost—Motor, $450; pump, $1700; well and casing, $500; installation, $100; complete plant $2800.

Remarks—In 1923 plant operated 738 hours and pumped 43.2 acre-feet of water. Estimated efficiency of plant 29.7 per cent.

Plant 33.

Location—Near Santa Clara, on corner of Gould and San Francisco Roads.

Plant—25-horsepower General Electric motor; direct-connected to a Type D. W., Byron Jackson turbine pump.

Cost—Complete plant $7434.

Remarks—In 1923 plant operated 371 hours and pumped 49 acre-feet of water. Estimated plant efficiency 53.4 per cent.

Plant 34.

Location—Santa Clara at Alviso and Saratoga Roads.

Plant—50-horsepower Westinghouse motor; connected to a Layne and Bowler pump, serial No. 3418.

Cost—Complete plant $5000.

Remarks—In 1923 plant operated 698 hours and pumped 62.4 acre-feet of water. Estimated plant efficiency 28.8 per cent.

Plant 35.

Location—Three and one-half miles east of San Jose on Alum Rock Road.

Plant—50-horsepower General Electric motor; belt-connected to a Western turbine pump in a pit 60 feet deep.

Cost—Motor, $1150; pump, $1900; well and casing, $1200; additional items, $200; Complete plant, $4450.

Remarks—In 1923 plant operated 740 hours and pumped 48.8 acre-feet of water. Estimated plant efficiency 29.4 per cent.

Plant 36.

Location—First and Rincon streets in Campbell.

Plant—75 horsepower General Electric motor, connected to a 10-inch Layne and Bowler pump.

Cost—Complete plant $12,000.

Remarks—In 1923 plant operated 1105 hours and pumped 184.8 acre-feet of water. Supplies some domestic water in addition to irrigating 280 acres of orchard. Estimated plant efficiency 43.2 per cent.

Plant 37.

Location—Saratoga Ave., eight miles from San Jose.

Plant—40-horsepower Wagner motor; type of pump unknown.

Cost—Complete plant $4100.

Remarks—In 1923 plant operated 798 hours and pumped 57.8 acre-feet of water. Estimated plant efficiency 36.8 per cent.

Plant 38.

Location—Four miles southeast of San Jose on McKee Road.

Plant—30-horsepower Western Electric motor; connected to Layne and Bowler pump.

Cost—Motor, $600; pump, $2500; well and casing, $4000; installation, $700; extra pipe $420; complete plant, $8220.

Remarks—In 1923 plant operated 1910 hours and pumped 46.8 acre-feet of water. Estimated efficiency of plant 32.1 per cent.

Plant 39.

Location—Cupertino, on Homestead Ave.

Plant—50-horsepower General Electric motor; connected to a 12-inch Byron Jackson deep-well turbine pump.

Cost—Complete plant $7800.

Remarks—In 1923 plant operated 326 hours and pumped 27 acre-feet of water. Estimated plant efficiency 40 per cent.

Plant 40.

Location—Five miles from San Jose on the road to Los Gatos.

Plant—75-horsepower Westinghouse motor; connected to a Layne and Bowler pump.

Cost—Motor and pump, $4990; complete plant estimated at $8000.

Remarks—In 1923 plant operated 368 hours and pumped 65.6 acre-feet of water. Estimated plant efficiency 52.6 per cent.

Plant 41.

Location—Near Blaney Station at Cupertino.

Plant—50-horsepower Fairbanks-Morse motor; connected to a 10-inch Western Well Co., deep-well turbine pump.

Cost—Motor, $700; pump, $3000; well and casing, $2350; complete plant $6050.

Remarks—In 1923 operated 533 hours and pumped 34.2 acre-feet of water. Estimated plant efficiency 37.4 per cent.

Plant 42.

Location—Near Lawrence Station at Cupertino.

Plant—75-horsepower Fairbanks-Morse motor; connected to a Western Well Works, deep-well turbine pump in a pit 100 feet deep.

Cost—Complete plant estimated at $8000.

Remarks—In 1923 plant operated 1180 hours and pumped 275 acre-feet of water. Several orchards are irrigated from this pump.

Plant 43.

Location—One and one-half miles south of Cupertino on Saratoga Road.

Plant—35-horsepower Westinghouse motor; belt-connected to a 10-inch Krogh turbine pump.

Cost—Complete plant $4900.

Remarks—In 1923 plant operated 890 hours and pumped 31.1 acre-feet of water.

Plant 44.

Location—Los Gatos, Union Ave., at S. P. R. R. crossing.

Plant—75-horsepower General Electric motor; belt-connected to a Layne and Bowler deep-well turbine pump.

Cost—Motor, $1150; pump, $5000; well and casing, $8500; installation, $270; house and derrick, $500; complete plant, $15,400.

Remarks—In 1923 plant operated 952 hours and pumped 133.2 acre-feet of water. Estimated efficiency of plant 32.2 per cent. Two other wells were abandoned here.

Plant 45.

Location—Santa Clara Valley, off Quito Road.

Plant—100-horsepower Wagner motor; connected to a No. 12 Bean deep-well turbine pump.

Cost—Complete plant estimated at $15,000.

Remarks—In 1923 plant operated 918 hours and pumped 132.2 acre-feet of water.

Plant 46.

Location—Off Quito Road, Santa Clara Valley.

Plant—100-horsepower Wagner motor; belt-connected to a Western deep-well turbine pump.

Cost—Motor, $1150; pump, $4330; well, casing, and installation, $9820; complete plant, $15,400.

Remarks—In 1923 operated 1080 hours and pumped 79.2 acre-feet of water.

Plant 47.

Location—On Quito Road, Santa Clara Valley.

Plant—50-horsepower General Electric motor; connected to a Layne and Bowler pump.

Cost—Motor, $1150; pump, $3200; complete plant estimated at $9000.

Remarks—In 1923 plant operated 623 hours and pumped 38.7 acre-feet of water.

Plant 48.

Location—Lexiton Road and Homestead St., Santa Clara.

Plant—30-horsepower Westinghouse motor; belt-connected to a No. 6 Bean two-stage vertical centrifugal pump set in a concrete pit 6 by 6 by 70 feet.

Cost—Complete plant $3250.

Remarks—Amount of water pumped and hours operated could not be ascertained. Capacity of pump 1.38 cu. ft. per second.

PLATE VII.

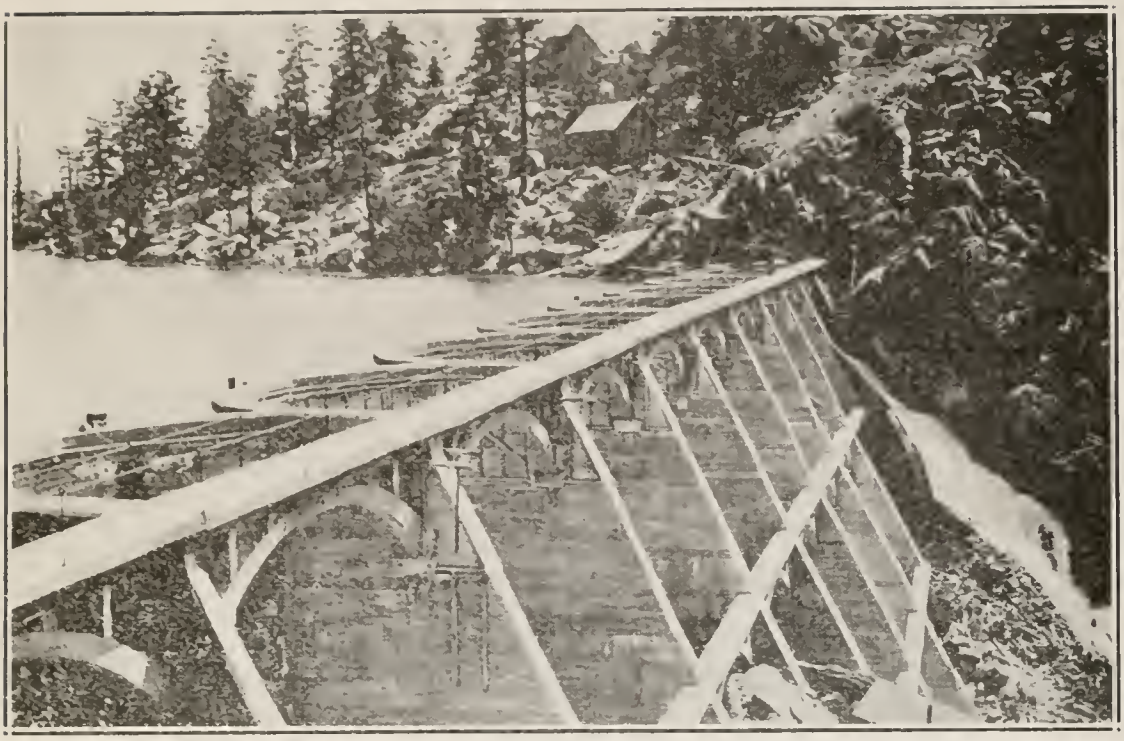

FIG. 1. Bear Valley Dam in the San Bernardino Mountains, storing irrigation water for important citrus areas in San Bernardino County.

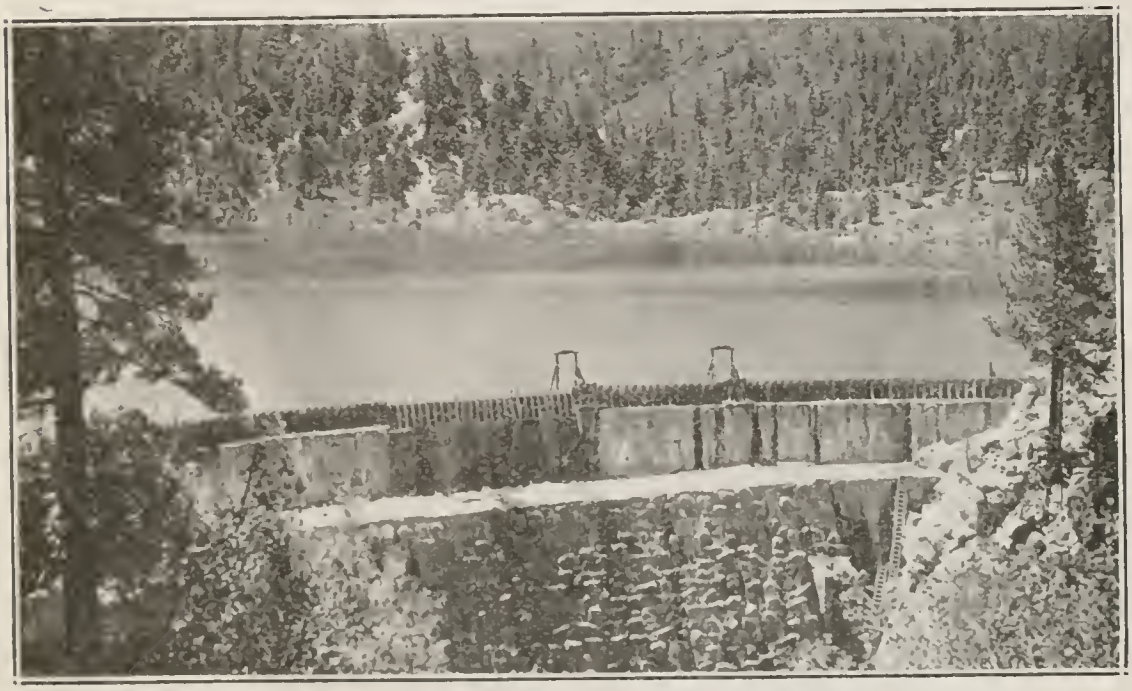

FIG. 2. Hemet Dam, Riverside County, built to supply irrigation water to the vicinity of Hemet.

Plant 49.

Location—Two miles east of Morgan Hill, Santa Clara County.

Plant—40-horsepower General Electric submersible motor, connected to a seven stage 9½-inch Byron Jackson turbine pump.

Cost—Complete plant $4400.

Remarks—In 1923 operated 1910 hours and pumped 76.4 acre-feet of water. Estimated plant efficiency 48.2 per cent.

Plant 50.

Location—San Martin, Santa Clara County.

Plant—40-horsepower Fairbanks-Morse motor; connected to a Campbell-Budlong deep-well special pump.

Cost—Complete plant $4478.

Remarks—In 1923 plant operated 369 hours and pumped 64.9 acre-feet of water. Plant efficiency estimated at 33.7 per cent.

Plant 51.

Location—San Martin, Santa Clara County, one mile east of S. P. R. R. on Church Ave.

Plant—15-horsepower General Electric motor; direct-connected to a Byron Jackson 10-inch pump.

Cost—Motor and pump, $1640; complete plant $3130.

Remarks—In 1923 operated 186 hours and pumped 16 acre-feet of water. Estimated efficiency of plant 44.8 per cent.

Plant 52.

Location—Gilroy, on Church Ave.

Plant—20-horsepower Robbins-Meyers motor; belt-connected to a 10-inch Western turbine pump.

Cost—Motor, pump, well, casing, and installation, $2600; additional items, $100; complete plant $2700.

Remarks—In 1923 plant operated 285 hours and pumped 26.6 acre-feet of water. Plant efficiency estimated at 26 per cent.

Plant 53.

Location—Gilroy, on Church Ave., one half mile east of S. P. R. R.

Plant—20-horsepower Crocker-Wheeler motor; belt-connected to a Western deep-well turbine pump in pit 40 feet deep.

Cost—Motor, $390; pump, $1400; well and casing, $485; installation, $40; house, $50; complete plant $2365.

Remarks—In 1923 operated 911 hours and pumped 106 acre-feet of water. Plant efficiency estimated at 32.7 per cent.

Plant 54.

Location—Gilroy, state highway and Church Ave.

Plant—30-horsepower Fairbanks-Morse motor; belt-connected to a 7-inch Campbell-Budlong deep-well turbine pump.

Cost—Motor and pump, $1600; well and casing, $1000; installation, $70; house, $40; complete plant $2710.

Remarks—In 1923 plant operated 532 hours and pumped 88 acre-feet of water. Efficiency of plant estimated at 27.9 per cent.

Plant 55.

Location—3 miles northeast of Watsonville.

Plant—7½-horsepower Westinghouse horizontal motor; direct-connected to a United Iron Works pump. Source of water, Pinto Lake.

Cost—Motor, pump, and pipe, $350; installation, $50; complete plant $400.

Remarks—In 1923 plant operated 481 hours and pumped 32.3 acre-feet of water. Plant efficiency estimated at 27.6 per cent.

Plant 56.

Location—Watsonville on Beach Road.

Plant—15-horsepower Fairbanks-Morse motor; connected to a Bean horizontal centrifugal pump. Artesian well.

Cost—Motor, $500; complete plant $1000.

Remarks—In 1923 plant operated 339 hours and pumped 30.8 acre-feet of water. Efficiency of plant estimated at 50 per cent.

Plant 57.

Location—One mile east of Watsonville.

Plant—20-horsepower Fairbanks-Morse horizontal motor; direct-connected to a 6-inch Fairbanks-Morse pump, in concrete pit 10 feet deep.

Cost—Motor and pump, $840; well and casing, $725; pit and additional items, $750; electric work, $90; complete plant $2405.

Remarks—In 1923 plant operated 806 hours and pumped 129.7 acre-feet of water. Plant efficiency estimated at 50.6 per cent.

Plant 58.

Location—Two miles south of Chualar, Monterey County.

Plant—20-horsepower General Electric horizontal motor; direct-connected to a No. 6 Byron Jackson side-suction pump in wooden pit 18 feet deep.

Cost—Motor and pump, $1850; pit, house and installation, $500; complete plant $2350.

Remarks—In 1923 plant operated 3910 hours and pumped 712 acre-feet of water. Estimated efficiency of plant 49.5 per cent.

Plant 59.

Location—Eight miles west of Modesto, Stanislaus County.

Plant—20-horsepower Robbins-Meyers motor; direct-connected to a 10-inch Byron Jackson type S horizontal double-suction pump set in a concrete pit 12 feet deep. Source of water Tuolumne River.

Cost—Complete plant $3403.66.

Remarks—In 1923 plant operated 1607 hours and pumped 562 acre-feet of water.

Plant 60.

Location—South of Turlock allotment 66, Delhi State Land Settlement, Merced County.

Plant—20-horsepower U. S. motor; connected to a Sterling Unitype turbine pump.

Cost—Complete plant $1500.

Remarks—In 1923 plant operated 3330 hours and pumped 532 acre-feet of water. Estimated efficiency of pump 35.3 per cent.

Plant 61.

Location—One mile west of Delhi, Merced County.

Plant—15 horsepower U. S. motor; connected to a Sterling turbine pump. Drainage well.

Cost—Complete plant $1500.

Remarks—In 1923 plant operated 4140 hours and pumped 538 acre-feet of water. Estimated efficiency of plant 40 per cent.

Plant 62.

Location—Several miles northeast of Delhi, Merced County.

Plant—15-horsepower Westinghouse motor; direct-connected to a Byron Jackson vertical centrifugal pump in a concrete pit. Pumps water from a canal.

Cost—Complete plant $1200.

Remarks—In 1923 plant operated 619 hours and pumped 126.8 acre-feet of water. Estimated efficiency of plant 60.7 per cent.

Plant 63.

Location—One mile west of Chowchilla, Madera County, on 13th Road.

Plant—3-horsepower Fairbanks-Morse motor; connected to a Krogh centrifugal pump in pit.

Cost—Motor, $200; pump, $300; well and casing, $50; installation, $50; complete plant $600.

Remarks—In 1923 estimated plant operated 656 hours and pumped 24.2 acre-feet of water. Plant efficiency estimated at 24.2 per cent.

Plant 64.

Location—One-half mile west of Chowchilla, Madera County, on Robertson Road.

Plant—10-horsepower Westinghouse motor; connected to a horizontal centrifugal pump.

Cost—Motor and pump installed, $850; well and casing $300; additional items, $150; complete plant $1300.

Remarks—In 1923 plant operated 1084 hours and pumped 42.3 acre-feet of water, lifting water 3 feet higher than surge level. Estimated efficiency of plant 34.8 per cent.

Plant 65.

Location—Four miles east of Visalia on Porterville Road.

Plant—10-horsepower Westinghouse motor; connected to a No. 5 Fresno pump in pit 6 feet deep.

Cost—Motor and pump, $1000; well and casing, $150; installation, $100; pit and house, $100; complete plant $1350.

Remarks—In 1923 plant operated 872 hours and pumped 102.8 acre-feet of water. Estimated efficiency of plant 45.7 per cent.

Plant 66.

Location—Two miles north of Exeter.

Plant—7½-horsepower Fairbanks-Morse motor; direct-connected to a Bean horizontal centrifugal pump, set in an elliptical concrete pit 25 feet deep.

Cost—Motor and pump, $1000; well, $139; pit, $133; complete plant $1300.

Remarks—In 1923 plant operated 1638 hours and pumped 36.9 acre-feet of water. Plant efficiency estimated at 19.6 per cent.

PLATE VIII.

FIG. 1. A typical irrigation reservoir of the foothill belt near Pomona, filled from pumping plant.

FIG. 2. Cross-furrow irrigation of walnuts in Orange County.

Plant 67.

Location—Two and one-half miles from Exeter on highway to Lindsay.

Plant—3-horsepower Century motor; connected to a No. 3 Standfield-McKnight deep-well plunger pump.

Cost—Motor, pump, and installation, $983; well and casing, $491; additional items, $50.

Remarks—In 1923 plant operated 2240 hours and pumped 22.2 acre-feet of water. Plant efficiency estimated at 40.8 per cent.

Plant 68.

Location—Four miles from Lemon Cove on Exeter Highway.

Plant—10-horsepower Fairbank-Morse motor; connected to a Bean Spray vertical turbine pump.

Cost—Complete plant $1410.

Remarks—In 1923 plant operated 3025 hours and pumped 154 acre-feet of water. Plant efficiency estimated 65 per cent or more.

Plant 69.

Location—One-half mile north of Lindsay.

Plant—5-horsepower General Electric motor; connected to a Brisco-Morley pump.

Cost—Motor and pump, $1200; well and casing, $450; additional items, $250; complete plant $1900.

Remarks—In 1923 plant operated 4405 hours and pumped 61.6 acre-feet of water. Plant efficiency estimated 49.6 per cent. Pump pulled three times in 1923. Cover crop grown.

Plant 70.

Location—Six miles southeast of Porterville.

Plant—15-horsepower General Electric motor; connected to a Keystone deep-well double acting pump.

Cost—Complete plant $4500.

Remarks—In 1923 plant operated 3630 hours and pumped 69 acre-feet of water. Efficiency of plant eltimated at 63.6 per cent.

Plant 71.

Location—Six miles south of Tulare on highway.

Plant—15-horsepower Robbins-Meyers motor; direct-connected to a No. 6 Superior pump in pit 18 feet deep.

Cost—Motor and pump, $1030; well and casing, $100; complete plant $1130.

Remarks—In 1923 plant operated 3350 hours and pumped 296 acre-feet of water. Efficiency of plant estimated at 35 per cent.

Plant 72.

Location—Two and one-fourth miles northwest of McFarland, Kern County.

Plant—10-horsepower General Electric motor; connected to a Byron Jackson deep-well turbine pump.

Cost—Complete plant $1450.

Remarks—In 1923 plant operated 5830 hours and pumped 166.5 acre-feet of water. Efficiency of plant estimated at 41.1 per cent. Water pumped into reservoir 18 hours and irrigates 6 hours.

the
ower
lata
ings

ower
, 27

rges
e 29

umn
25 is

umn
umn

l, 17
cost
The
ncre-
s 30
pital
ty of
0.
rized
not

IN

Per
-ft. per
. lift

$0.065
1.317

f the
lants
rated
span-
gated

15.2
than

TABLE 30.—COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Private Pumping Plants in Sacramento Valley, 1922.

	Plant			Well			Pump			Acreage irrigated			Cost of plant		Annual costs for plant				Annual cost per acre-foot pumped				Annual cost of water					
																	Fixed charges				Fixed charges		Per acre-foot		Per acre		Per acre-foot per foot lift	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No.	Location	Year installed.	Size of motor, horse-power.	Size, inches	Depth, feet	Depth to static water, feet.	Total hours operated	Lift, feet	Discharge, cubic feet per second	Total acres	Kind of crops	Duty of water per acre, acre-feet	Total	Per acre irrigated	Power bill	Estimated attendance	Interest on cost of plant at six per cent	Taxes, insurance, depreciation, repairs, renewals, (estimated)	Power bill	Attendance	Interest	Taxes, insurance, depreciation, repairs, renewals	Excluding interest on cost of plant	Including interest on cost of plant	Excluding interest on cost of plant	Including interest on cost of plant	Excluding interest on cost of plant	Including interest on cost of plant
	ELECTRIC.																											
1	Dixon	1911	10	12	72	37	570	40 0	0 67	13	Alfalfa	2 45	$1,100	$84 62	$118 29	$22 80	$66 00	$99 00	$3 71	$0 71	$2 07	$3 10	$7 52	$9 59	$18 42	$23 50	$0 188	$0 240
2	Dixon	1918	15	0	0		955	40 0	1 75	130	Orchard	1 07	750	5 77	242 63	38 20	45 00	67 50	1 74	0 27	0 32	0 48	2 49	2 81	2 66	3 01	0 062	0 070
3	Dixon	1915	7½		100	42	561	42 0	0 32	7	Alfalfa	2 16	800	114 29	83 21	22 44	48 00	72 00	5 49	1 48	3 17	4 75	11 72	14 89	25 31	32 18	0 279	0 355
4	Dixon		10		100	37	1,215	42 0	0 88	30	Alfalfa	2 96	1,000	33 33	271 00	48 60	60 00	90 00	3 05	0 55	0 68	1 01	4 61	5 29	13 65	15 65	0 110	0 126
5	Dixon	1918	30	12	125	39	1,366	42 0	2 27	70	Alfalfa	3 69	1,500	21 43	470 29	54 64	90 00	135 00	1 83	0 21	0 35	0 52	2 56	2 91	9 44	10 74	0 061	0 070
6	Dixon		35		200	35	1,710	43 0	2 40	76	Alfalfa	4 50	2,450	32 24	697 25	68 40	147 00	220 50	2 04	0 20	0 43	0 64	2 88	3 31	12 96	14 90	0 067	0 077
7	Dixon		25		120	35	1,216	45 0	1 91	65	Alfalfa	3 05	2,450	37 69	444 55	49 84	147 00	220 50	2 25	0 25	0 74	1 11	3 61	4 35	11 02	13 27	0 080	0 097
8	Dixon		50		120	35	1,740	45 0	2 53	76	Alfalfa	4 80	2,450	32 24	754 29	69 60	147 00	220 50	2 07	0 19	0 40	0 60	2 86	3 26	13 73	15 65	0 064	0 072
9	Dixon		25		120	35	925	45 0	1 94	46	Alfalfa	3 24	2,450	53 26	387 25	37 00	147 00	220 50	2 60	0 25	0 99	1 48	4 33	5 32	14 03	17 21	0 086	0 118
10	Dixon	1916	15	12	100	32	920	45 0	0 70	25	Alfalfa	2 43	1,000	40 00	260 73	36 80	60 00	90 00	4 44	0 61	0 99	1 48	6 53	7 52	15 87	18 27	0 145	0 167
11	Dixon	1921	10	12	96	34	631	46 5	1 05	20	Alfalfa	2 98	1,235	61 75	173 11	25 24	74 10	115 15	2 90	0 42	1 24	1 86	5 18	6 42	15 43	19 13	0 111	0 138
12	Dixon	1922	25		200	35	499	48 0	2 04	70	Alfalfa	1 21	2,450	35 00	280 84	19 96	147 00	220 50	3 31	0 23	1 73	2 60	6 14	7 87	7 43	9 53	0 128	0 164
13	Dixon		10		90	40	2,417	50 0	1 10	20	Alfalfa		800	40 00	500 35	96 68	48 00	72 00	2 26	0 44	0 22	0 33	3 03	3 25	33 45	35 85	0 061	0 065
14	Davis	1919	35			24		35 9	1 11		Trees, alfalfa	1 63	2,690	99 70	162 57	24 32	161 40	242 10	2 89	0 43	2 87	4 30	7 62	10 49	12 42	17 10	0 212	0 292
15	Davis	1919	25	12	265		213	42 0	0 71	40	Trees, alfalfa		3,556	88 90	155 02	8 52	213 36	320 00	12 30	0 68	16 93	25 40	38 38	55 31	12 28	17 70	0 911	1 317
16	Davis	1913	10	12	125	18	362	44 0	1 46	10	Alfalfa	4 40	1,000	100 00	97 12	14 48	60 00	90 00	2 21	0 33	1 36	2 05	4 59	5 95	20 20	26 20	0 104	0 135
17	Davis	1922	20	12	109	18	404		0 85	12	Alfalfa	2 39	2,500	208 33	156 99	16 16	150 00	225 00	5 47	0 56	5 22	7 84	13 87	19 09	33 13	45 63		
18	Davis	1922	20	12	130		319	60 0	1 26	50	Pasture, alfalfa	67	2,225	44 50	148 40	12 76	133 50	200 25	4 43	0 38	3 98	5 97	10 78	14 76	7 23	9 89	0 180	0 246
19	Davis	1915	20	12	133	14	344	62.0	0 81	12	Alfalfa	1 94	1,100	91 67	141 99	13 76	66 00	99 00	6 09	0 59	2 83	4 25	10 93	13 76	21 20	26 70	0 177	0 222
20	Davis	1920	25	12	141	50	627	73.0	1 64	40	Alfalfa	1 57	2,590	64 75	254 17	25 08	155 40	233 10	4 05	0 40	2 47	3 71	8 16	10 63	12 82	16 70	0 112	0 146
21	Woodland	1906	100	12	200	17	1,194	30 0	8 34	200	Alfalfa	4 15	12,000	60 00	1,614 71	47 76	720 00	1,080 00	1 94	0 06	0 87	1 30	3 30	4 17	13 70	17 30	0 110	0 139
22	Winters	1919	40	12	86	27	597	47 0	3 57	80	Miscellaneous	2 23	3,000	37 50	435 23	23 88	180 00	270 00	2 44	0 13	1 01	1 52	4 09	5 10	9 12	11 37	0 087	0 108
	DISTILLATE.																											
23	Winters	1915	16		36	21	453	28 0	1 85	21	Alfalfa	3.35	2,000	95 24	81 60	45 30	120 00	280 00	1 16	0 64	1 70	3 98	5 78	7 48	19 37	25 08	0 206	0 267
24	Winters	1919	20	12	187	35	750	46 0	1 23	37	Orchard	2 07	1,250	33 78	153 00	75 00	75 00	175 00	2 00	0 98	0 98	2 29	5 27	6 25	10 92	12 94	0 115	0 136
25	Woodland	1920	65	12		17	504	25 0	8 44	120		2 97	13,500	112 50	393 60	201 60	810 00	1,890 00	1 10	0 57	2 28	5 31	6 98	9 26	20 72	27 50	0 279	0 370

COST OF PUMPING UNDER PRIVATE PUMPING PLANTS.

Description of Table 30—This table has been prepared to show the annual cost of water to irrigators under 25 pumping plants in the lower Sacramento Valley for 1922. It also shows other pumping plant data and factors affecting the cost of water. Most of the column headings are self-explanatory and will not be taken up in detail here.

Column 16, "Power bill," includes minimum charge per horsepower installed, energy charge per kilowatt-hour, and surcharge. Table 27 shows the power rates effective for 1922 in Sacramento Valley.

Column 23, under "Fixed charges," includes all estimated fixed charges except interest on cost of plant which is shown in column 22. Table 29 gives these in detail.

Columns 24 and 25 show "Annual cost of water per acre-foot." Column 24 is equal to the summation of columns 20, 21, and 23. Column 25 is equal to column 24 plus column 22, "Interest."

Columns 26 and 27 show "Annual cost of water per acre." Column 26 is equal to column 24 multiplied by the duty of water shown in column 13. Column 27 is equal to column 25 multiplied by column 13.

Summary of table 30—Of the 22 electric pumping plants tested, 17 irrigate alfalfa entirely while 3 irrigate some alfalfa. The annual cost of water per acre for irrigating alfalfa ranges from $9.53 to $45.63. The cost per acre-foot varies from $2.91 to $19.09, while the cost per acre-foot per foot lift ranges from $0.065 to $0.355. The lowest lift is 30 feet and the highest is 73 feet. The cost of the pumping plant, or capital invested, varies from $21.43 to $208.33 per acre. The minimum duty of water for alfalfa is 1.21 acre-feet per acre while the maximum is 4.80.

Columns 9, 8, 11, 11, 15, 25, 27, and 29 in Table 30, will be summarized in Table 31. The distillate plants numbers 23, 24, and 25, are not included.

TABLE 31—SUMMARY OF COST OF PUMPING FOR ELECTRIC PLANTS TESTED IN SACRAMENTO VALLEY.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Minimum	30	213	7	0.67	$5.77	$2.81	$3.01	$0.065
Maximum	73	2,417	200	4.80	208.33	55.31	15.63	1.317

Many of the plants in this section operate only a small portion of the irrigation season. This would indicate that the capacity of such plants is too large for the acreage irrigated. The number of hours operated could be increased several times and the acreage irrigated might be expanded accordingly. This would decrease the fixed charges per acre irrigated and per acre-foot of water pumped.

The plant efficiency of the 25 pumping plants tested ranges from 15.2 to 62 per cent. Three were below 20 per cent while ten were more than 40 per cent.

Locatio

Plant—
deep-

Cost—N
$50.

Remark
Plant

Locatio

Plant—
turbi

Cost—(

Remark
Plan

Locatio

Plant—

Cost—I
plan

Remarl
Plan
crop

Locatio

Plant—
doul

Cost—

Remar
Effic

Locatio

Plant-
pun

Cost—

Remar
Effic

Locatio

Plant
well

Cost—

Remar
Effic
hou

COST OF PUMPING UNDER PRIVATE PUMPING PLANTS.

Description of Table 30—This table has been prepared to show the annual cost of water to irrigators under 25 pumping plants in the lower Sacramento Valley for 1922. It also shows other pumping plant data and factors affecting the cost of water. Most of the column headings are self-explanatory and will not be taken up in detail here.

Column 16, "Power bill," includes minimum charge per horsepower installed, energy charge per kilowatt-hour, and surcharge. Table 27 shows the power rates effective for 1922 in Sacramento Valley.

Column 23, under "Fixed charges," includes all estimated fixed charges except interest on cost of plant which is shown in column 22. Table 29 gives these in detail.

Columns 24 and 25 show "Annual cost of water per acre-foot." Column 24 is equal to the summation of columns 20, 21, and 23. Column 25 is equal to column 24 plus column 22, "Interest."

Columns 26 and 27 show "Annual cost of water per acre." Column 26 is equal to column 24 multiplied by the duty of water shown in column 13. Column 27 is equal to column 25 multiplied by column 13.

Summary of table 30—Of the 22 electric pumping plants tested, 17 irrigate alfalfa entirely while 3 irrigate some alfalfa. The annual cost of water per acre for irrigating alfalfa ranges from $9.53 to $45.63. The cost per acre-foot varies from $2.91 to $19.09, while the cost per acre-foot per foot lift ranges from $0.065 to $0.355. The lowest lift is 30 feet and the highest is 73 feet. The cost of the pumping plant, or capital invested, varies from $21.43 to $208.33 per acre. The minimum duty of water for alfalfa is 1.21 acre-feet per acre while the maximum is 4.80.

Columns 9, 8, 11, 11, 15, 25, 27, and 29 in Table 30, will be summarized in Table 31. The distillate plants numbers 23, 24, and 25, are not included.

TABLE 31—SUMMARY OF COST OF PUMPING FOR ELECTRIC PLANTS TESTED IN SACRAMENTO VALLEY.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft	Per acre	Per acre-ft. per ft. lift
Minimum	30	213	7	0.67	$5.77	$2.81	$3.01	$0.065
Maximum	73	2,117	200	1.80	208.33	55.31	15.63	1.317

Many of the plants in this section operate only a small portion of the irrigation season. This would indicate that the capacity of such plants is too large for the acreage irrigated. The number of hours operated could be increased several times and the acreage irrigated might be expanded accordingly. This would decrease the fixed charges per acre irrigated and per acre-foot of water pumped.

The plant efficiency of the 25 pumping plants tested ranges from 15.2 to 62 per cent. Three were below 20 per cent while ten were more than 40 per cent.

Description of Table 32—Tabulations in this table have been compiled showing the annual cost of water to irrigators under 47 pumping plants in Santa Clara Valley, San Joaquin Valley, and in other sections of the state, for 1923. Other information on pumping plants and factors which affect the cost of water are also included in the table.

The methods of compiling the data for Table 32 were similar to those used for Table 30. The rates for electrical power were different from those in effect in 1922. Table 28 shows the power schedules in detail for 1923.

Summary of Table 32—All the plants tested were driven by electricity. Fair comparisons of cost of pumping water in different sections are difficult to make, as power schedules, local ground water conditions, and number of hours of operation, have a wide range of variation. The plant efficiency of the plants tested ranged from 19.6 to 65 per cent. Three were below 25 per cent, nineteen 40 per cent or over, and nine 50 per cent or over.

Plants numbered 26 to 48, inclusive, in Santa Clara Valley, furnished water for irrigating deciduous fruit trees, and should give a fair indication of cost of pumped water in that territory. Table 33 shows a summary of these plants.

TABLE 33—SUMMARY OF COST OF PUMPING IN SANTA CLARA VALLEY.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Minimum	29.0	326	46	0.36	$18 75	$4 04	$5 34	$0 125
Maximum	208.0	1,910	300	2.23	144 21	56 34	33 08	378

Pumping plants numbered 59 to 72 are scattered throughout San Joaquin Valley. Table 34 summarizes the data for these plants.

TABLE 34—SUMMARY OF PUMPING PLANTS TESTED IN SAN JOAQUIN VALLEY.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Minimum	10.5	619	6	1.23	$13 30	$1 56	$6 96	$0 040
Maximum	249.9	5,830	145	4.16	179 30	18 42	48 08	301

Cost of pumped water for various crops—Only four plants irrigating citrus trees were tested, but these should give a fair idea of the cost of water for oranges in Central California.

TABLE 35—SUMMARY OF PUMPING PLANTS IRRIGATING CITRUS TREES.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Minimum	81.0	2,240	8.50	2.30	$35 25	$1 21	$16 22	$0 010
Maximum	249.9	4,405	10.00	3.85	179 30	18 42	48 08	227

been
tests

ating
table
which

NTRAL

Per
e-ft. per
t. lift

$0 052
060
061

t full
plants

ıping
ed to
night
ıping
ith a
ı the
ıount
form
such
total
and
not.
vater
dules
nt is

ın is
ed if
mers
ıbors
profit
ities.
ated
s of

how
vater
alla-
ial.*

ng.

TABLE 32.—COST OF WATER FOR IRRIGATION IN CALIFORNIA.

Private Electric Pumping Plants in Central California. 1923.

Plant				Well			Pump			Acreage irrigated		Cost of plant		Annual costs for plant				Annual cost per acre-foot pumped				Annual cost of water					
																Fixed charges				Fixed charges		Per acre-foot		Per acre		Per acre-foot per foot lift	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
No.	Location	Year installed	Size of motor, horse-power	Size, inches	Depth, feet	Depth to static water level, feet	Total hours operated	Lift, feet	Discharge, cubic feet per second	Total acres	Kind of crops	Duty of water per acre-foot	Total	Per acre irrigated	Power bill	Estimated attendance	Interest on cost of plant at six per cent	Taxes, insurance, depreciation, repairs, renewals (estimated)	Power bill	Attendance	Interest	Taxes, insurance, depreciation, repairs, renewals	Excluding interest on cost of plant	Including interest on cost of plant	Excluding interest on cost of plant	Including interest on cost of plant	Excluding interest on cost of plant	Including interest on cost of plant
26	San Jose	1911	30	10	80	20	820	20.0	1 96	80	Prunes	1 67	$1,500	$18 75	$284 52	$32 89	$90 00	$135 00	$2 12	$0 24	$0 67	$1 01	$3 37	$4 04	$5 63	$6 75	$0 116	$0 139
27	San Jose	1919	15	10	120	30	363	39.2	1 12	65	Nursery	0 52	1,370	21 08	129 00	14 52	82 20	123 30	3 78	0 43	2 42	3 63	7 81	10 26	4 08	5 34	0 200	0 262
28	San Jose	1912	35				454	48 0	2 82	80	Prunes	1 33	3,300	41 25	306 60	18 16	198 00	297 00	2 88	0 17	1 86	2 79	5 81	7 70	7 77	10 24	0 122	0 160
29	Los Gatos		20		52		937	70 0	0 48	75	Orchard	0 50	[2]2,000	26 67	199 73	37 48	120 00	180 00	5 28	0 99	3 17	4 76	11 03	14 20	5 51	7 10	0 158	0 203
30	Santa Clara		40	16	404	25	638	71.0	3 20	90	Pears, plums	1 88	6,535	72 61	404 27	25 52	392 10	588 15	2 92	0 15	2 31	3 47	6 54	8 85	12 30	16 64	0 092	0 125
31	San Jose	1905	50		196	55	997	74 0	1 28	48	Fruit	2 23	6,400	133 33	586 00	39 88	384 00	576 00	5 48	0 37	3 59	5 39	11 24	14 83	25 08	33 08	0 152	0 200
32	Mountain View	1918	20	12	125	27	738	84 0	0 70	50	Fruit	0 86	2,800	56 00	269 58	29 52	168 00	252 00	6 24	0 68	3 89	5 83	12 75	16 64	10 96	14 32	0 152	0 198
33	Santa Clara		25				371	85 4	1 58	90	Pears, plums	0 54	7,434	82 60	230 76	14 84	446 04	669 06	4 71	0 30	9 10	13 66	18 67	27 77	10 08	14 98	0 218	0 325
34	Santa Clara	1920	50	14	276	71	698	88 0	1 07	77	Prunes, apricots	0 81	5,000	65 00	439 17	27 92	300 00	450 00	7 04	0 45	4 81	7 21	14 70	19 51	11 90	15 80	0 167	0 222
35	San Jose	1920	50	24	210	60	740	103 8	0 78	60	Prunes, peaches	0 81	4,450	74 17	417 59	29 60	267 00	400 50	8 55	0 61	5 47	8 20	17 36	22 83	14 06	18 50	0 167	0 220
36	Campbell	1920	75	16	412	111	1,106	131 5	2 00	280	Prunes, apricots	0 66	12,000	42 86	1,127 74	44 24	720 00	1,080 00	6 10	0 24	3 89	5 84	12 18	16 07	8 04	10 61	0 093	0 122
37	San Jose		40				708	139 0	0 86	82	Peaches, apricots	0 71	4,100	50 00	470 53	31 92	246 00	369 00	8 14	0 55	4 25	6 38	15 07	19 32	10 70	13 71	0 108	0 139
38	San Jose	1922	30	14	495	80	1,910	144 5	0 29	57	Prunes, apricots	0 82	8,220	144 21	434 98	76 40	493 20	739 80	9 20	1 63	10 53	15 82	26 74	37 37	21 92	30 57	0 385	0 258
39	Cupertino	1920	50	14	265	136	326	149 0	0 99	76	Prunes, apricots	0 36	7,800	102 63	338 08	13 01	468 00	702 00	12 52	0 48	17 33	26 01	39 01	56 34	14 05	20 27	0 262	0 378
40	Santa Clara		75				368	162.0	2 13			0 50	8,000		563 11	14 72	480 00	720 00	8 58	0 22	7 32	10 97	19 77	27 09	9 89	13 55	0 122	0 167
41	Cupertino		50	16	342	135	533	173 0	0 76	60	Orchard	0 57	6,050	100 83	491 77	21 32	363 60	544 50	11 75	0 62	10 62	15 91	28 31	38 93	16 13	22 20	0 164	0 225
42	Cupertino		75		254		1,180		2 80		Orchard	[1]0 60	[3]8,000		847 02	47 20	480 00	720 00	3 08	0 17	1 75	2 62	5 87	7 62	5 87	7 62		
43	Cupertino	1917	35	12	281	120	890	195 0	0 42		Prunes, apricots	[1]0 50	4,600		439 17	35 60	294 00	441 00	14 12	1 14	9 16	14 18	29 44	38 90	14 72	19 45	0 151	0 200
44	Los Gatos	1922	75	14	912	110	952	208 0	1 68	300	Prunes, peaches	0 44	15,100	51 33	1,267 17	38 08	924 00	1,386 00	9 52	0 29	6 94	10 40	20 21	27 15	8 89	11 95	0 097	0 131
45	Santa Clara		100	14	1,089	125	918		1 73	170	Prunes, peaches	0 78	[1]15,000	88 25	1,088 06	36 72	960 03	1,350 00	8 24	0 28	6 81	10 22	18 74	25 55	14 61	19 93		
46	Santa Clara		100	16	1,001	125	1,080	[2]200 0	0 88	180	Prunes, apricots	0 44	15,400	85 56	1,160 44	43 20	924 00	1,386 00	14 65	0 54	11 67	17 49	32 68	44 35	14 38	19 52	0 163	0 222
47	Santa Clara		50	14	565	125	623	[2]200 0	0 74	90	Fruit	0 43	9,000	100 00	375 04	24 92	540 00	810 00	9 69	0 64	13 95	20 92	31 25	45 20	13 43	19 43	0 156	0 226
48	Santa Clara	1918	30	10		50		60 0	1 38	46	Prunes	[1]1 10	3,250	70 65	193 53	24 00	195 00	292 50					[4]12 59	[4]15 61	17 62	21 86	0 210	0 260
49	Morgan Hill	1923	40	14	300		1,910	207.0	0 48	36	Berries	2 12	4,400	122 22	874 40	76 40	264 00	396 00	11 45	1 00	3 45	5 18	17 63	21 08	37 38	44 70	0 085	0 102
50	San Martin	1922	40		355	26	369	53.0	2 11	75		0 865	1,478	59 71	487 65	14 76	268 68	403 02	7 51	0 23	4 14	6 21	13 95	18 09	12 13	15 73	0 263	0 341
51	San Martin	1923	15	12	98		186	67 9	1 03	50	Prunes	0 32	3,130	62 60	134 55	7 44	187 80	281 70	8 41	0 45	11 73	17 60	26 46	38 19	8 47	12 22	0 389	0 562
52	Gilroy	1920	20	12	150	23	285	41 0	1 12	28	Prunes	0 95	2,700	96 43	239 05	11 40	162 00	243 00	8 98	0 43	6 09	9 13	18 54	24 63	17 61	23 40	0 452	0 601
53	Gilroy	1914	20			23	911	43 5	1 39	61	Prunes, alfalfa	1 74	2,365	38 80	432 85	36 44	141 96	212 85	4 08	0 34	1 34	2 01	6 43	7 77	11 18	13 52	0 148	0 179
54	Gilroy	1921	30	12	170	18	532	45 0	1 36	40	Truck, alfalfa	2 20	2,710	67 75	404 00	21 28	162 60	243 90	4 59	0 24	1 85	2 77	7 60	9 45	16 72	20 79	0 169	0 210
55	Watsonville	1917	7½		Lake		481	20.2	0 81	62	Apples, truck	0 52	400	6 45	115 30	19 24	24 00	36 00	3 57	0 60	0 74	1 11	5 28	6 02	2 75	3 13	0 261	0 298
56	Watsonville	1920	15	12	154	0	339	40 0	1 09	96	Apples, pears	0 32	1,000	10 42	161 00	13 56	60 00	90 00	5 23	0 41	1 95	2 92	8 59	10 54	2 75	3 38	0 215	0 263
57	Watsonville	1923	20	12	170	19	806	18 3	1 93	124	Apples, apricots	1 046	2,405	19 40	398 10	32 24	144 30	216 45	3 07	0 25	1 11	1 67	4 99	6 10	5 24	6 41	0 103	0 126
58	Chualar	1919	20	16	270	20	3,910	46 2	2 18	140	Alfalfa	5 09	2,350	16 78	1,200 94	156 40	141 00	211 50	1 68	0 22	0 20	0 30	2 20	2 40	11 19	12 21	0 048	0 052
59	Modesto	1919	20		River		1,607	10 5	4 18	145	Orchard, alfalfa	3 88	3,403	23 48	451 04	64 28	204 18	306 27	0 80	0 11	0 36	0 54	1 45	1 81	5 63	7 02	0 138	0 172
60	Turlock		20				3,330	27 3	1 90				1,500		481 93	133 20	90 00	135 00	0 91	0 25	0 17	0 25	1 41	1 58			0 052	0 058
61	Turlock	1923	15				4,140	34 0	1 56				1,500		446 46	165 60	90 00	135 00	0 83	0 31	0 17	0 25	1 39	1 56			0 041	0 046
62	Delhi	1923	15		Canal		619	23 4	2 46				1,200		121 42	24 76	72 00	108 00	0 96	0 20	0 57	0 85	2 01	2 58			0 086	0 110
63	Chowchilla	1923	3	12	74	12	656	25 8	0 45	6	Truck	4 03	600	100 00	71 53	26 21	36 00	54 00	2 96	1 08	1 49	2 23	6 27	7 76	25 28	31 28	0 243	0 301
64	Chowchilla	1922	10	10	108		1,084	56 0	0 46	31	Peaches, apricots	1 36	1,300	41 95	202 22	43 36	78 00	117 00	4 78	1 02	1 84	2 77	8 57	10 41	11 65	14 15	0 153	0 186
65	Visalia	1920	10	10	65	21	872	28 0	1 41	55	Prunes, alfalfa	1 87	1,350	24 55	144 65	34 88	81 00	121 50	1 41	0 34	0 79	1 18	2 03	3 72	5 48	6 96	0 105	0 133
66	Exeter	1920	7½		139		1,638	48 5	0 27	30	Grapes	1 23	1,300	43 33	185 94	65 52	78 00	117 00	5 04	1 78	2 11	3 17	9 99	12 10	12 28	14 88	0 206	0 250
67	Exeter	1921	3	10	151	57	2,240	81 0	0 11	8½	Oranges	2 61	1,521	179 30	99 59	89 60	91 44	137 16	4 08	4 04	4 12	6 18	14 30	18 42	37 32	48 08	0 176	0 227
68	Lemon Cove	1923	10	12	133		3025	104 2	0 61	40	Oranges	3 85	1,410	35 25	317 99	121 00	84 60	126 90	2 06	0 78	0 55	0 82	3 66	4 21	14 09	16 22	0 035	0 040
69	Lindsay	1909	5	12	300	85	4,405	128 0	0 17	20	Oranges	3 08	1,900	95 00	206 15	176 20	114 00	171 00	3 35	2 86	1 85	2 77	8 98	10 83	27 67	33 37	0 070	0 085
70	Porterville	1922	15	12	427	210	3,630	249 0	0 22	30	Oranges	2 30	4,500	150 00	405 93	145 20	270 00	405 00	5 88	2 10	3 91	5 86	13 84	17 75	31 83	40 84	0 055	0 071
71	Tulare	1922	15	12	97	18	3,350	45 0	1 06	85	Alfalfa	3 48	1,130	13 30	500 77	134 00	67 80	101 70	1 69	0 45	0 23	0 34	2 48	2 71	8 63	9 43	0 055	0 060
72	McFarland	1923	10	12	203	64	5,830	90 0	0 41	46	Alfalfa, grapes	4 16	1,450	36 25	457 61	233 20	87 00	130 50	2 75	1 40	0 52	0 78	4 93	5 45	20 52	22 68	0 055	0 061

[1]Estimated.

The cost of irrigation water for deciduous trees has already been shown in Table 33, for Santa Clara Valley. There were not enough tests made in other districts to permit fair comparisons.

In the summary of Table 30 the cost of pumped water for irrigating alfalfa in lower Sacramento Valley was discussed. The following table will give summary of three typical plants shown in Table 32, which irrigate alfalfa.

TABLE 36—SUMMARY OF TYPICAL PUMPING PLANTS IRRIGATING ALFALFA IN CENTRAL CALIFORNIA.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Plant No. 58	46.2	3,910	140	5 09	$16 78	$2 40	$12 21	$0 052
Plant No. 71	45 0	3,350	85	3 48	13 30	2 71	9 43	060
Plant No. 72	90 0	5,830	40	4 16	36 25	5 45	22 68	061

These are excellent illustrations of plants designed to operate at full capacity. The fixed charges are reduced to a minimum as the plants irrigate larger acreages and operate a greater number of hours.

Reducing overhead expenses—Many farmers do not utilize their pumping plants fully. Either the acreage under irrigation is small compared to the pump capacity or the plant is run only a portion of the time it might be operated. The irrigator may find it easier to run a large pumping unit for a few hours rather than to irrigate the same acreage with a smaller plant operating perhaps several days. But the interest on the capital invested in the excessively large plant and the increased amount that must be charged to depreciation and other fixed charges, form considerable items in the total annual cost of irrigation water. In such cases the fixed charges generally amount to over 50 per cent of the total annual cost. Fixed charges such as interest, taxes, insurance, and depreciation go on continuously, whether the plant is operated or not. Some irrigators fail to realize this and measure the cost of pumped water by the amount of their oil or electric power bills. Many power schedules have a demand or minimum charge which is paid whether the plant is run few or many hours.

In cases where a larger pumping plant has been installed than is needed to supply the acreage irrigated, the situation may be remedied if more land can be brought under irrigation. In some instances farmers have increased the number of acres covered by supplying neighbors with water. However, care should be taken not to sell water for profit as private plants entering such service may be declared public utilities. In some sections of the state mutual water companies or unincorporated associations have been formed to reduce the overhead expenses of pumping.

The value of the crop grown is the potent factor which determines how high an irrigator can afford to pump water. However, before water can be pumped economically for the irrigation of any crop, the installation of the right type of pumping plant for local conditions is essential.*

*Farmers' Bulletin No. 1404, U. S. D. A., Pumping from Wells for Irrigation, by Paul A. Ewing.

Descrip
showing t
in Santa
state, for
affect the

The m
used for
those in
1923.

Summa
Fair con
difficult
and num
plant effi
Three we
per cent

Plants
water for
tion of co
of these

TAI

Minimum
Maximum

Pumpi
Joaquin

TABLE

Minimum
Maximum

Cost of
trees wer
oranges

TAI

Minimum
Maximum

The cost of irrigation water for deciduous trees has already been shown in Table 33, for Santa Clara Valley. There were not enough tests made in other districts to permit fair comparisons.

In the summary of Table 30 the cost of pumped water for irrigating alfalfa in lower Sacramento Valley was discussed. The following table will give summary of three typical plants shown in Table 32, which irrigate alfalfa.

TABLE 36—SUMMARY OF TYPICAL PUMPING PLANTS IRRIGATING ALFALFA IN CENTRAL CALIFORNIA.

	Lift, feet	Time operated, hours	Area irrigated, acres	Duty of water per acre, acre-ft.	Cost of plant per acre	Annual cost of water		
						Per ac. ft.	Per acre	Per acre-ft. per ft. lift
Plant No. 58	46.2	3,910	140	5.09	$16 78	$2 40	$12 21	$0 052
Plant No. 71	45 0	3,350	85	3.48	13 30	2 71	9 43	060
Plant No. 72	90 0	5,830	40	4.16	36 25	5 45	22 68	061

These are excellent illustrations of plants designed to operate at full capacity. The fixed charges are reduced to a minimum as the plants irrigate larger acreages and operate a greater number of hours.

Reducing overhead expenses—Many farmers do not utilize their pumping plants fully. Either the acreage under irrigation is small compared to the pump capacity or the plant is run only a portion of the time it might be operated. The irrigator may find it easier to run a large pumping unit for a few hours rather than to irrigate the same acreage with a smaller plant operating perhaps several days. But the interest on the capital invested in the exeessively large plant and the increased amount that must be charged to depreciation and other fixed charges, form considerable items in the total annual cost of irrigation water. In such cases the fixed charges generally amount to over 50 per cent of the total annual cost. Fixed charges such as interest, taxes, insurance, and depreciation go on continuously, whether the plant is operated or not. Some irrigators fail to realize this and measure the cost of pumped water by the amount of their oil or electric power bills. Many power schedules have a demand or minimum charge which is paid whether the plant is run few or many hours.

In cases where a larger pumping plant has been installed than is needed to supply the acreage irrigated, the situation may be remedied if more land can be brought under irrigation. In some instances farmers have increased the number of acres covered by supplying neighbors with water. However, care should be taken not to sell water for profit as private plants entering such service may be declared public utilities. In some sections of the state mutual water companies or unincorporated associations have been formed to reduce the overhead expenses of pumping.

The value of the crop grown is the potent factor which determines how high an irrigator can afford to pump water. However, before water can be pumped economically for the irrigation of any crop, the installation of the right type of pumping plant for local conditions is essential.*

*Farmers' Bulletin No. 1404, U. S. D. A., Pumping from Wells for Irrigation, by Paul A. Ewing.

CAPITAL COST AND VALUE OF IRRIGATION WATER.

Cost of irrigation systems—Under many irrigation districts the cost of developing water and building irrigation works is shown by the total authorized bonded indebtedness. However, before attempting to compare the bonded cost per acre of two districts it would be necessary to make a detailed study of the conditions in each case. The bonds for one district may cover a drainage system, a pipe or lined canal distribution system delivering water to every 10 acres, and an expensive pumping equipment, while the other extreme may exist where the district bonds only cover a gravity system, without provisions for drainage or storage, and with unlined canals distributing water to every 160 acres.

In Table 8, under column 18, the total authorized bonded debt per acre is shown. For northern California it varies from $12.63 to $86.53 per acre. The minimum in central California is $3.84 per acre, while the maximum reaches $107.92 per acre. In southern California the figures range from $26.50 to $100.22 per acre.

The par value of the capital stock of mutual water companies may show approximately the cost of developing water and building irrigation works. However, in some instances part of the construction cost was met by a bond issue, while in other cases the capital stock covered commissions to promoters, profit to land agents, or cost of so-called water rights in addition to cost of works. In southern California the par value of stock per acre varies from $5 to $400, but the more common amounts are $50 and $100 per acre. For other sections of the state the par value of capital stock varies from $1 to $100 per acre.

The investment in private electric pumping plants in Santa Clara Valley ranged from $18.75 to $144.21 per acre, with an average of $71.39 per acre. Plants tested in San Joaquin Valley showed costs ranging from $13.30 to $179.30 per acre. In the Sacramento Valley the average cost of plants tested is $63.04 per acre, with range from $5.77 to $208.33 per acre.

Market value of irrigation water—Perhaps one of the best indications of the market value of irrigation water may be obtained from the selling price of shares of stock in mutual water companies organized to deliver water solely to their stockholders. In addition to the cost of developing water, the market value is influenced by the supply of and demand for the shares of stock, the appurtenance of stock, reliability of water supply, priority of rights, indebtedness, and annual cost of operation and maintenance, as well as the value of agricultural crops which may be produced by irrigation, depending on the climate and locality.

Probably nowhere in the West has the value of irrigation water become better established than in southern California. The market value of stock of 29 of the 78 mutual water companies shown in Table 18, falls below $100 per acre; 24 have a market value of $200 or more, while 9 reach $300 or more.

The late C. E. Tait, Senior Irrigation Engineer of the U. S. Bureau of Public Roads, made studies of the value of water in southern California covering many years, and was of the opinion that "gravity water as a class has a market at $1500 to $2000 per miner's inch* or its equivalent amount, and under the most favorable combination of circumstances

*Fifty miner's inches=1 cubic foot per second.

$2500 per miner's inch, while pumped water is worth $1000 to $1500 for the same amount."

There are several methods of determining the market value of water per miner's inch. Perhaps the most common way is as follows: Under many mutual water companies a share of water stock is entitled to a definite portion of a miner's inch and this usually ranges from one-tenth to one miner's inch per share, where one share serves an acre of land. Thus the market value of a miner's inch of water may be determined by dividing the market value of stock per share, by the amount of miner's inches each share is entitled to. For example: If a share of water stock will sell for $300 and each share is entitled to one-fifth of a miner's inch, the market value of one miner's inch would be $1500.

The amount of water to which each share is entitled, is not so easy to determine for some companies, while in others a shareholder may not receive all the water his stock calls for. For these reasons the market value of irrigation water per acre-foot delivered may be a better means of showing the value of water. This may be determined by dividing the market value of stock per acre by the average duty of water in acre-feet per acre for the system. Using the above method, the market value of irrigation water per acre-foot delivered for a few representative companies in southern California for the year 1922 will be shown. A system delivering 4.3 acre-feet per acre from the Colorado River with a market value of stock of $35.00 per acre has a market value per acre-foot of $8.14. Of the companies having a market value of stock of $100 per acre, the duty ranges from 0.56 to 2.00 acre-feet per acre; hence the market value per acre-foot varies from $50.00 to $178.57. Another company having a market value of stock of $250.00 per acre and a duty of water of 2 acre-feet per acre would have a market value per acre-foot of $125.00. A company irrigating about 4000 acres of citrus trees, using 1.37 acre-feet of water per acre, and with a market value of stock $300 per acre, has irrigation water worth $218.98 per acre-foot of water.

The enhanced value of land due to the intensive cultivation possible when water is used for irrigation, varies widely throughout California. In some sections of the state where rainfall is plentiful, limited crops may be profitably grown without irrigation; while in other parts of the state with very little rainfall, irrigated land worth several hundred dollars an acre would be practically worthless if deprived of its only available water supply. There are many instances where the increase in the value of land has amounted to several times the cost of making the water available for its irrigation. From the standpoint of the irrigator, the enhanced value of land, due to irrigation, is largely determined by the increased value of crops grown and by his investment in the water system.

SUMMARY.

Types of enterprises—Four kinds of enterprises, Public Utilities, Irrigation Districts, Mutual Water Companies, and Private Pumping Plants, have been considered in this report on the cost of irrigation water to farmers. Cost data for these types of enterprises are not always comparable as their forms of organization are different, and comparisons between two systems of the same type of enterprise are often difficult to make because factors affecting the cost of water have a wide range of variation.

Annual cost of irrigation water—For public utility water companies the minimum cost of irrigation water per acre is $0.56 and the maximum $32.67. The cost per acre-foot varies from $0.30 to $25.14. These figures include interest on capital invested.

For irrigation districts the lowest cost of water per acre is $0.90, and the highest $24.69. The minimum cost per acre-foot is $0.37 and the maximum $22.19. These costs do not include interest on retired bonds. With the exception of two special districts the interest on retired bonds amounts to only a few cents.

Under mutual water companies the lowest cost of water per acre is $0.83, the highest $60.07. The cost per acre-foot varies from $0.40 to $50.91. Interest on capital invested is included in these figures.

For the private electric pumping plants tested in Sacramento Valley in 1922 the cost of water per acre ranges from $3.01 to $45.63. The lowest cost per acre-foot is $2.81, the highest $55.31.

The plants tested in central California in 1923 show costs varying from $3.13 to $48.08 per acre. The cost of water per acre-foot ranges from $1.56 to $56.34. The lowest cost per acre-foot per foot lift is $0.04, while the highest is $0.601.

Annual cost of water for various crops—The following tables give summaries of the cost of water under different types of enterprises in California for various crops:

TABLE 37—SUMMARY OF ANNUAL COST OF WATER FOR CITRUS TREES.

Types of enterprise	Annual cost of irrigation water			
	Per acre		Per acre-foot	
	Minimum	Maximum	Minimum	Maximum
Public utilities	$5 00	$32 67	$1 47	$25 14
Irrigation districts	90	24 69	60	16 35
Mutual water companies	1 84	60 07	55	50 91
Private pumping plants[1]	16 22	48 08	4 21	18 42

[1]The figures given for private pumping plants are not comparable with other enterprises as they represent only a few plants in San Joaquin Valley and are for 1923 while the others are for 1922.

TABLE 38—SUMMARY OF ANNUAL COST OF WATER FOR DECIDUOUS TREES AND VINES.

Types of enterprise	Annual cost of irrigation water			
	Per acre		Per acre-foot	
	Minimum	Maximum	Minimum	Maximum
Public utilities	$0 56	$25 14	$0 30	$25 14
Irrigation districts	90	24 69	53	22 19
Mutual water companies	83	41 28	40	27 67
Private pumping plants[1]	5 34	33 08	1 01	56 34

[1]The figures shown for private pumping plants are for Santa Clara Valley in 1923 and are not comparable with other enterprises.

PLATE IX.

FIG. 1. Murray Dam, below San Diego; an important unit in the Cuyamaca irrigation system.

FIG. 2. Contour irrigation of citrus orchard in the Vista section of San Diego County.

TABLE 39—SUMMARY OF ANNUAL COST OF WATER FOR ALFALFA.

Types of enterprise	Annual cost of irrigation water			
	Per acre		Per acre-foot	
	Minimum	Maximum	Minimum	Maximum
Public utilities	$0 56	$25 14	$0 30	$25 14
Irrigation districts	90	21 00	53	8 90
Mutual water companies	83	41 28	40	16 82
Private pumping plants[1]	9 53	45 63	2 91	19 09

[1]These figures are for 17 tested pumping plants in Sacramento Valley and are not comparable with other enterprises.

Cost of irrigation enterprises—Under irrigation districts the authorized bonded debt per acre has a wide variation. For northern California it varies from $12.63 to $86.53 per acre. The minimum in central California is $3.84 per acre, while the maximum reaches $107.92 per acre. In southern California the figures range from $26.50 to $100.22 per acre.

The par value of mutual water companies stock may indicate the cost of the main irrigation system. In southern California this value per acre varies from $5 to $400, but the more common amounts are $50 and $100 per acre. For other sections of the state the par value of capital stock varies from $1 and $100 per acre.

For private electric pumping plants tested in Sacramento Valley the average cost of plant per acre irrigated was $63.04. The cost varied from $5.77 to $208.33 per acre. In Santa Clara Valley the investment in pumping plants ranged from $18.75 to $144.21 per acre with an average of $71.39 per acre. Plants tested in San Joaquin Valley cost from $13.30 to $179.30 per acre.

PLATE X.

FIG. 1. Border irrigation of alfalfa in Imperial Irrigation District.

FIG. 2. Dredging silt from Imperial Canal; a major item of irrigation maintenance in Imperial Valley.

APPENDIX.

The following report on "Cost of Water for Irrigation in Southern California" has been taken from the original papers prepared by the late C. E. Tait, Senior Irrigation Engineer, U. S. Department of Agriculture, which appeared in the Seventh Biennial Report of the California State Department of Engineering and in the February, 1923, issue of the California Citrograph. The cost data given in these two papers were taken from a table compiled by the author under the supervision of Mr. Tait. This tabulation has never been published and will appear at the end of this Appendix. The field data were collected in 1919 and 1920 by F. D. Bowlus, H. F. Blaney, H. M. Lukens, Thos. H. McCarthy and C. E. Tait.

COST OF WATER FOR IRRIGATION IN SOUTHERN CALIFORNIA.

By C. E. TAIT.

In no part of Western United States has the value of irrigation water become better established than in the fruit growing sections of southern California. This value may be stated in terms of a definite quantity of water or it may take form in the price of shares in a mutual water company.

The capital value of water is greater where the annual charges for delivery to the land are low than where they are high. Chiefly for this reason the water user is, as a general rule, willing to pay more for a title to water diverted by gravity from the streams than for that pumped from wells. Gravity water as a class has market at $1500 to $2000 per miner's inch or its equivalent amount and under the most favorable combination of circumstances $2500 per miner's inch, while pumped water is worth $1000 to $1500 for the same amount. (The miner's inch used in southern California is the one-fiftieth (1/50) part of a cubic foot per second, and is not the statute inch of the state, which is the one-fortieth (1/40) part of a cubic foot per second.) In addition to the annual cost of making the water available, other influences on the capital value are the sufficiency and stability of the water supply, the legal character of the water right, and last, but not least, the value of the products of irrigation. It is the latter that makes the value of water in southern California exceed that of any other part of the arid region.

The position has been taken by some who have struggled with the problems of fixing water rates under public utilities that if all the facts were known it would be found that the market value of water is nothing more than approximately the total spent in developing the water, and that the proper way to value a water right is merely to determine the cost of the works that make the water available. Without discussing here the proper basis for rate fixing under public utility water companies, it is certain that this theory is not supported by the facts. As already suggested the present value of the stock of the older water companies that constructed gravity systems at low cost per acre, generally much exceeds the original cost, while the stock of the later organizations, so many of which must pump the water at greater annual cost of operation, has not appreciated much, if any. Conceding that part of the difference is due to water rights and amounts of indebtedness carried, both in favor of the older systems, it is clearly apparent that the water user gives a

d that the
1 first cost.
elop water
ases water
lepreciated
d extended
1 company
urrounding

gally make
where this
ised to the
land, and
ent market
ists under
ater appur-
em and to
andowners
any share

transfer of
sion of its
ler the last
out on the
and they
ount.
al in water
r they use
The total
the sum of
ncluded, is
the capital
ital stock;
sed at any
mpany are
deduction
the reason
not to the
ged to the

nies do not
provement
e made on
g expense.
by assess-
eir capital
nder state
e revenues
nt of water
water.
e first and
stock and

Prepared By C. E Tait.

Name of company	Location	Type of company	Percentage of water pumped	Area irrigated: Citrus trees, acres	Deciduous trees, acres	Alfalfa, acres	Truck and miscellaneous acres	Total, acres	Duty of water per acre-feet	Capital stock: Number of shares of stock issued	Par value of stock per share	Market value of stock per share	Average number of shares per acre	Value of stock per acre	Factors in cost of water: Interest on value of capital stock per acre at 6 per cent	Average annual assessment per acre	Water rate: Per hour-inch	Per acre-foot	Water charge per acre for average amount used	Amount per acre deposited in sinking fund or charged to capital stock	Cost of water: For first acre-foot: Excluding interest on value of capital stock	Including interest on value of capital stock	Per acre for average amount used: Excluding interest on value of capital stock	Including interest on value of capital stock	Per acre-foot for average amount used: Excluding interest on value of capital stock	Including interest on value of capital stock
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Alta Loma Mutual Water Co.	Alta Loma	Mutual	100	120				120	1 68	300	$80 00		1 00	$80 00	$4 80	None	$0 0015	$0 90	$1 51		$0 90	$5 70	$1 51	$6 31	$0 90	$3 76
Anaheim Union Water Co.	Anaheim	Mutual	10	7,500	500			8,000	1 61	8,004	100 00	$100 00	1 00	100 00	6 00	None	0079	4 75	7 65	$1 25	4 75	10 75	6 40	12 40	3 98	7 70
Arroyo Ditch and Water Co.	Downey	Mutual	0		2,500	1,500		4,000	2 00	3,698	5 00	20 00	0 92	18 40	1 10	$1 84	0069	1 14	8 28		5 98	7 08	10 12	11 22	5 06	5 61
Azusa Irrigating Co.	Azusa	Mutual	23	3,929				3,929	2 00	11,787	15 00	100 00	3 00	300 00	18 00	4 50	0029	1 74	3 48	0 75	5 49	23 49	7 23	25 23	3 62	12 62
Baldwin Park Water Co.	Baldwin Park	Mutual	100	166			103	269	1 02	269	20 00		1 00	20 00	1 20	0 50	0125	7 50	7 65		8 00	9 20	8 15	9 35	7 99	9 16
Banning Heights Mutual Water Co.	Banning	Mutual	0		600			600	1 03	11,000	15 00	15 00	10 00	150 00	9 00	None	0040	2 13	2 50		2 43	11 43	2 50	11 50	2 43	11 17
Banning Water Co.	Banning	Mutual	75		2,850			2,850	1 90	3,245	50 00	175 00	1 14	199 50	11 97	6 73	None	None	None		6 73	18 70	6 73	18 70	3 54	9 85
Banta Ditch Association	Whittier	Unincorporated	0	100	900			1,000	1 00	1,000		100 00	1 00	100 00	6 00	0 50	None	None	None		0 50	6 50	0 50	6 50	0 50	6 50
Beardslee Water Ditch Co.	Duarte	Mutual	25	800	10	25	275	1,110	0 70	630	31 80		0 57	18 18	1 09	2 74	None	None	None	0 45	2 29	3 38	2 29	3 38	3 27	4 83
Bear Valley Mutual Water Co.	Redlands	Mutual	0							83,527	20 00	20 00	9 00	180 00	10 80	7 20	None	None	None	1 13						
Crafton Water Co.	Redlands	Mutual	0	1,800				1 800	2 00	3,321	100 00	150 00	1 00	150 00	9 00	6 00	None	None	None	1 60	4 40	13 40	4 40	13 40	2 20	6 70
East Redlands Water Co.	Redlands	Mutual	0	443				443	2 00	443	100 00	150 00	1 00	150 00	9 00	8 00	None	None	None	0 55	7 45	16 45	7 45	16 45	3 73	8 23
Lugonia Park Water Co.	Redlands	Mutual	0	196				196	2 00	196	100 00	160 00	1 00	160 00	9 60	13 50	None	None	None	2 47	11 03	20 63	11 03	20 63	5 52	10 32
Redlands Water Co.	Redlands	Mutual	0	1,380				1,380	2 00	1,500	100 00	100 00	1 09	109 00	6 54	7 63	None	None	None	0 75	6 88	13 42	6 88	13 42	3 44	6 71
West Redlands Water Co.	Redlands	Mutual	0	806				806	2 00	806	100 00	125 00	1 00	125 00	7 50	16 00	None	None	None	5 35	10 65	18 15	10 65	18 15	5 33	9 08
California Domestic Water Co.	Whittier	Mutual	95	3,000				3,000	1 57	8,005	50 00	90 00	1 50	135 00	8 10	18 00	None	None	None	4 33	13 67	21 77	13 67	21 77	8 71	13 86
Canyon Water Company of Pomona	Pomona	Mutual	0	2,500				2,500	1 00	16,600	10 00	15 00	6 64	99 60	5 98	0 37	None	None	None		0 37	6 35	0 37	6 35	0 37	6 35
Capistrano Water Co.	Capistrano	Mutual	0		375	15	10	400	3 24	421	100 00	100 00	1 00	100 00	6 00	2 50	None	None	None		2 50	8 50	2 50	8 50	0 77	2 62
Carmel Water Co.	Montebello	Mutual	100					1,000	0 90	3,915	10 00		4 00	40 00	2 40	3 20	None	None	None		3 20	5 60	3 20	5 60	3 56	6 22
Cate Ditch Co.	Rivera	Mutual	0	250	800	300		1,350	2 10	2,743	1 00		2 00	2 00	0 12	1 00	None	None	None		1 00	1 12	1 00	1 12	0 42	0 47
Chino Water Co.	Chino	Mutual	100	50	950			1 000	0 72	950	100 00	100 00	1 00	100 00	6 00	None	0150	9 00	6 48		9 00	15 00	6 48	12 48	9 00	17 33
City Creek Water Co.	Highlands	Mutual	0	380				380	2 40	2,160	10 00	35 00	5 68	198 80	11 90	1 19	None	None	None		1 19	13 09	1 19	13 09	0 50	5 46
Citizens Land and Water Co. of Bloomington	Bloomington	Mutual	100	3,825	100	25	50	4,000	1 12	5,184	50 00	175 00	1 00	175 00	10 50	0 30	0075	4 50	5 04		4 80	15 30	5 34	15 84	4 77	14 14
Claremont Co-Op. Water Co.	Claremont	Mutual	100	400				400	2 71	5,034	10 00	15 00	10 00	150 00	9 00		0150	9 00	24 39		9 00	18 00	24 39	33 39	9 00	12 32
Columbia Land and Water Co.	Covina	Mutual	100	600				600	0 78	600	100 00	100 00	1 00	100 00	6 00	5 00	0350	21 00	16 38		26 00	32 00	21 38	27 38	27 42	35 10
Covina Irrigating Co.	Covina	Mutual	25	4,500				4,500	1 30	10,000	50 00	100 00	3 00	300 00	18 00	12 00	0021	1 26	1 64	1 35	9 91	27 91	10 29	28 29	7 92	21 76
Cucamonga Water Co.	Cucamonga	Mutual	45	2,300	700			3,000	0 85	3,582	100 00	100 00	1 19	119 00	7 14	9 25	None	None	None	3 57	5 68	12 82	5 68	12 82	6 68	15 08
Del Monte Irrigation Co.	Pomona	Mutual	100	1 800				1,800	1 66	226,000	10 00	17 00	12 55	213 35	12 80	9 41	None	None	None		9 41	22 21	9 41	22 21	5 67	13 38
Del Norte Water Co.	Ventura	Mutual	100				700	700	0 30	2,500	10 00	17 50	0 74	12 95	0 78	0 24	0208	12 50	3 75		12 74	13 52	3 99	4 77	13 30	15 90
Del Rosa Water Co.	Del Rosa	Mutual	20	545	40			585	1 00	110	100 00	100 00	0 20	20 00	1 20	5 00	None	None	None	2 57	2 43	3 63	2 43	3 63	2 43	3 63
Duarte Mutual Irrigation and Canal Co.	Duarte	Mutual	0	1,259				1,259	1 20	1,250	10 00	150 00	1 00	150 00	9 00	6 00	None	None	None	0 80	5 20	14 20	5 20	14 20	4 33	11 83
Escondido Mutual Water Co.	Escondido	Mutual	0	1,500			441	1,941	1 20	222,450	1 00	0 95	150 00	142 50	8 55	None	0083	5 00	6 00	1 33	4 07	12 22	5 07	13 22	4 22	11 02
Etiwanda Water Co.	Etiwanda	Mutual	0	800			1,200	2,000	1 26	2,300	100 00	300 00	1 10	300 00	18 00	4 00	None	None	None	1 00	3 00	21 00	3 00	21 00	2 38	16 67
Fillmore Irrigation Co.	Fillmore	Mutual	14	900	250		10	1,160	3 71	2,088	100 00	500 00	1 00	500 00	30 00	0 80	0045	2 70	10 00		3 50	33 50	10 80	40 80	2 91	10 99
Fontana Water Co.	Fontana	Mutual	25	3,500	300	20		3,820	1 88	3,909	100 00	200 00	1 00	200 00	12 00	9 00	None	None	None		9 00	21 00	9 00	21 00	4 79	11 17
Gage Canal Co.	Riverside	Mutual	73	6,144				6,144	2 21	12,288	50 00	100 00	2 00	200 00	12 00	None	0100	6 00	13 26	2 61	3 39	15 39	10 65	22 65	4 82	10 25
Gardena Water Supply Co.	Gardena	Mutual	100		20		480	500	1 41	730	5 00	2 00	1 46	2 92	0 18	None	0042	2 52	3 63		2 52	2 70	3 63	3 81	2 52	2 65
Garvey Water Co.	San Gabriel	Mutual	100	50	250		15	315	0 68	1,000	50 00		1 00	50 00	3 00	1 25	0275	16 50	11 22		17 75	20 75	12 47	15 47	18 33	22 75
Glendora Irrigating Co.	Glendora	Mutual	100	1,000				1,000	1 41	1,282	100 00	75 00	1 28	96 00	5 76	19 25	0300	18 00	25 38	10 00	27 25	33 01	34 63	40 39	24 58	28 65
Glendora Mutual Water Co.	Glendora	Mutual	100	1,000				1,000	1 36	1,123	100 00	100 00	1 12	112 00	6 72	11 20	0250	15 00	20 40	11 20	15 00	21 72	20 40	27 12	15 00	19 95
Gobernador Land and Water Co.	Carpinteria	Mutual	0	50	250			300	1 20	400	100 00		1 33	133 33	7 99	10 00	None	None	None	8 33	1 67	9 66	1 67	9 66	1 39	8 05
Hermosa Water Co.	Hermosa	Mutual	0	480				480	1 51	1,920	100 00	100 00	4 00	400 00	24 00	5 00	None	None	None	4 17	2 92	26 92	2 92	26 92	1 93	17 83
Iamosa Water Co.	Iamosa	Mutual	10	500				500	2 02	500	100 00	200 00	1 00	200 00	12 00	7 50	None	None	None	6 00	1 50	13 50	1 50	13 50	0 74	6 68
Imperial Irrigation District	El Centro	District														0 91										
Imperial Water Co. No. 1	Imperial	Mutual	0			37,545	77,307	114,850	3 15	99,066	10 00	25 00	0 80	20 00	1 20	1 87	0008	0 50	1 58		3 28	4 48	4 36	5 56	1 38	1 76
Imperial Water Co. No. 2	Holtville	Mutual	0					6,400	3 05	6,754	10 00	20 00	1 00	20 00	1 20	4 33	0008	0 50	1 53		5 74	6 94	6 77	7 97	2 22	2 61
Imperial Water Co. No. 3	Calipatria	Mutual	0					44,000	3 00	46,344	10 00	20 00	0 94	18 80	1 13	1 57	0008	0 50	1 50		2 98	4 11	3 98	5 11	1 33	1 70
Imperial Water Co. No. 4	Brawley	Mutual	0					19,000	3 02	19,801	10 00	15 00	1 00	15 00	0 90	1 60	0008	0 50	1 51		3 01	3 91	4 02	4 92	1 33	1 63
Imperial Water Co. No. 5	Holtville	Mutual	0					75,000	3 20	88,313	10 00	12 50	0 94	11 75	0 70	2 37	0008	0 50	1 60		3 78	4 48	4 88	5 58	1 53	1 74
Imperial Water Co. No. 6	Calexico	Mutual	0					20,510	3 00	18,981	10 00	12 50	0 94	11 75	0 70	2 50	0008	0 50	1 50		3 91	4 61	4 91	5 61	1 64	1 87
Imperial Water Co. No. 7	Holtville	Mutual	0					19,180	3 14	18,743	10 00	12 50	0 94	11 75	0 70	2 89	0012	0 75	2 35		4 55	5 25	6 15	6 85	1 96	2 18
Imperial Water Co. No. 8	Brawley	Mutual	0					38,000	2 89	39,050	25 00	20 00	0 94	18 80	1 13	1 72	0008	0 50	1 45		3 13	4 26	4 08	5 21	1 41	1 80
Imperial Water Co. No. 9	Calipatria	Mutual	0					18,000	3 00	18,007	10 00	16 25	0 94	15 28	0 92	2 60	None	None	None		3 57	4 49	3 57	4 49	1 19	1 50
Imperial Water Co. No. 12	Imperial	Mutual	0					12,100	3 20	15,300	25 00		1 00	25 00	1 50	4 17	0008	0 50	1 60		5 68	7 08	6 68	8 18	2 09	2 55
Imperial Southside Water Co.	Holtville	Mutual	0					18,000	3 10	18,300	10 00	20 00	1 00	20 00	1 20	2 67	0008	0 50	1 55		4 08	5 28	5 13	6 33	1 65	2 04
Irrigation Co. of Pomona	Pomona	Mutual	100	600	1,300		100	2,000	0 82	24,500	10 00	3 00	10 00	30 00	1 80	2 00	0083	4 98	4 08		6 98	8 78	6 08	7 88	7 12	9 61
John T. Carpenter Water Co.	El Modena	Mutual	0	970			30	1,000	1 92	3,200	10 00	70 00	3 20	224 00	13 44	12 80	None	None	None		12 80	26 24	12 80	26 24	6 67	13 66
La Verne Land and Water Co.	La Verne	Mutual	100	300				300	1 81	241½	50 00		1 00	50 00	3 00	None	0450	27 00	48 87		27 00	30 00	48 87	51 87	27 00	28 65
La Verne Irrigation Co.	San Dimas	Mutual	100	185				185	2 16	200	25 00	150 00	1 00	150 00	9 00	None	0250	15 00	32 40		15 00	24 00	32 40	41 40	15 00	19 17
Los Nietos Irrigation Co.	Whittier	Mutual	0	160	1,150	160	30	1,500	2 00	1,500	10 00	10 00	1 00	10 00	0 60	1 00	None	None	None		1 00	1 60	1 00	1 60	0 50	0 80
Lugonia Water Co.	Redlands	Mutual	0	2,750	50			2,800	1 20	3,150	100 00	140 00	1 12	156 80	9 40	1 68	None	None	None		1 68	11 08	1 68	11 08	1 40	9 23
Lytle Creek Water and Imp. Co.	Rialto	Mutual	0	2,800			200	3,000	2 64	3,238	50 00	200 00	1 08	216 00	12 96	8 61	None	None	None	3 33	5 31	18 27	5 31	18 27	2 01	6 92
Marygold Mutual Water Co.	Bloomington	Mutual	100	600			100	700	0 64	1,120	1 00		1 00	1 00	0 06	None	0175	10 50	6 72		10 50	10 56	6 72	6 78	10 50	10 58
Mentone Irrigating Co.	Mentone	Mutual	0	400				400	1 80	4,000	100 00		1 00	100 00	6 00	0 10	None	None	None		0 10	6 10	0 10	6 10	0 06	3 39
Moneta Water Co.	Gardena	Mutual	100		15	75	645	735	1 86	2,050	25 00	25 00	3 00	75 00	4 50	None	0125	7 50	13 95	0 85	6 65	11 15	13 10	17 60	7 05	9 46
Montalvo Mutual Water Co.	Montalvo	Mutual	100	200	265		441	906	0 80	906	50 00	75 00	1 00	75 00	4 50	None	0025	1 50	1 20		1 50	6 00	1 20	5 70	1 50	7 13
Montebello Land and Water Co.	Montebello	Mutual	100	1,080			120	1,200	0 99	1,250		100 00	1.00	100 00	6 00	10 00	None	None	None		10 00	16 00	10 00	16 00	10 10	16 16
Montalvo Irrigation Co.	Montalvo	Mutual	100				126	126	1 27	126	100 00		1.00	100 00	6 00	None	0104	6 24	7 92		6 24	12 24	7 92	13 92	6 24	10 95
Monte Vista Irrigation Co.	Ontario	Mutual	100	500	450			950	0 82	1,000	10 00		1 00	10 00	0 60	1 00	0150	9 00	7 38		10 00	10 60	8 38	8 98	10 22	10 95
Mound Water Co.	Ventura	Mutual	100		240		552	792	1 00	792	100 00	100 00	1 00	100 00	6 00	0 93	0104	6 21	6 21		7 17	13 17	7 17	13 17	7 17	13 17
Mount Vernon Water Co.	San Bernardino	Mutual	67	310		40		350	2 49	500	50 00	150 00	1 43	214 50	12 87	9 65	None	None	None		9 65	22 52	9 65	22 52	3 87	9 05
North Fork Water Co.	San Bernardino	Mutual	0	1,800				1,800	2 23	4,800	100 00	120 00	2 70	324 00	19 14	1 62	None	None	None		1 62	21 06	1 62	21 06	0 73	9 44
Old Settlers Water Co.	Cucamonga	Mutual	47	280				280	1 90	33,840	1 00	1 00	121 00	121 00	7 26	7 26	None	None	None		7 26	15 52	7 26	15 52	3 82	8 17
Palomares Irrigation Co.	Pomona	Mutual	100	250	100			350	1 31	6,000	10 00	14 00	17 15	240 10	14 40	6 86	None	None	None		6 86	21 86	6 86	21 86	5 24	16 68
Palo Verde Mutual Water Co.	Palo Verde	Mutual	0					32,000	1 00	35,372	10 00	35 00	1 00	35 00	2 10	5 80	None	None	None		5 80	7 90	5 80	7 90	1 45	1 98
Puente Land and Water Co.	Puente	Mutual	0	40	800	160		1,000	1 20	216,000	1 00	1 00	216 00	216 00	12 96	0 80	None	None	None		0 80	13 76	0 80	13 76	0 67	11 47
Rincon Ditch Co.	Whittier	Mutual	0	150	651		100	921	1 50	921	25 00		1 00	25 00	1 50	5 00	None	None	None		5 00	6 50	5 00	6 50	3 33	4 33
Riverside Water Co.	Riverside	Mutual	10	1,925	192	2,528	3,466	8 111	2 72	19,721	10 00	40 00	2 00	80 00	4 80	None	0062	3 72	6 00		3 72	8 52	6 00	10 80	2 21	3 97
Riverside Highland Water Co.	Riverside	Mutual	100	2,340		10		2,350	2 00	4,526	10 00	100 00	1 90	190 00	11 40	5 70	0062	3 75	7 50	4 25	5 20	16 60	8 95	20 35	4 48	10 18
Rivino Water Co.	Riverside	Mutual	100	809				809	1 99	2,107	25 00		2 00	50 00	3 00	2 50	0104	6 24	12 42		8 74	11 74	14 92	17 92	7 50	9 00
San Antonio Irrigating Co.	Downey	Mutual	0			800	400	1,200	2 00	8,224	5 00	11 00	6 82	75 00	4 50	3 76	0020	1 20	2 40		4 96	9 46	6 16	10 66	3 08	5 33
San Antonio Water Co.	Ontario	Mutual	20	5,000				5,000	1 20	6,064	100 00	250 00	1 21	302 50	18 15	12 10	None	None	None	1 60	10 50	28 65	10 50	28 65	8 75	23 87
San Cayetano Mutual Water Co.	Santa Paula	Mutual	100	372	80			452	1 58	1,231	50 00	57 25	2 00	114 50	6 87	2 50	0222	13 30	21 01		15 80	22 67	23 51	30 38	14 88	19 23
Santa Ana Valley Irrigation Co.	Orange	Mutual	10	10,000	5,000		2,428	17,428	1 85	17,128	5 00	117 00	1 00	117 00	7 02	1 65	0028	1 68	3 11	0 86	2 47	9 49	3 90	10 92	2 11	5 91
San Dimas Water Co.	San Dimas	Mutual	90	2,200				2,200	1 67	2,178	100 00	100 00	1 00	100 00	6 00	5 00	0250	15 00	25 05	2 00	18 00	24 00	28 05	34 05	16 79	20 39
Saticoy Development Co.	Saticoy	Mutual	100		508		20	528	1 27	528	40 00	80 00	1 00	80 00	4 80	None	0180	10 80	13 71		10 80	15 60	13 71	18 51	10 80	14 57
Serrano Water Association	El Modena	Unincorporated	0	500	75		372	947	1 71	947		150 00	1 00	150 00	9 00	3 00	None	None	None		3 00	12 00	3 00	12 00	1 75	7 02
South Mountain Water Co.	Redlands	Mutual	50	500				500	2 08	1,000	100 00		2 00	200 00	12 00	26 00	None	None	None	4 00	22 00	34 00	22 00	34 00	10 57	16 35
Standefer Water Co.	Rivera	Mutual	0	900	368			1,268	1 60	12,685	1 00		10 00	10 00	0 60	0 10	0005	0 30	0 48		0 70	1 30	0 88	1 48	0 55	0 93
South Side Improvement Co.	Fillmore	Mutual	60	1,300	150			1,450	2 23	2,916	10 00	28 75	2 00	57 50	3 45	4 00	0040	2 40	5 35		6 40	9 85	9 35	12 80	4 19	5 74
Sunset Water Co. of Cucamonga	Cucamonga	Mutual	100	475				475	1 07	2,400	30 00		5 05	151 50	9 08	7 58	None	None	None		7 58	16 67	7 58	16 67	7 09	15 58
Sunny Slope Water Co.	Lamanda Park	Mutual	100	1,000	25	25	350	1,400	1 02	1,400	100 00	110 00	1 00	110 00	6 60	3 05	None	None	None		3 05	9 65	3 05	9 65	2 99	9 16
Temescal Water Co.	Corona	Mutual	93	4,082				4,082	2 01	8,333	100 00	70 00	1 77	123 90	7 43	24 78	None	None	None	5 31	19 47	26 90	19 47	26 90	9 55	13 18
Terrace Water Co.	Colton	Mutual	100	270	30	9		309	2 33	368	100 00		1 00	100 00	6 00	17 50	None	None	None		17 50	23 50	17 50	23 50	7 51	10 08
Thermal Belt Water Co.	Santa Paula	Mutual	85	1,275	300			1,575	2 49	1,500	100 00	200 00	0 95	190 00	11 40	4 00	0062	3 72	9 26		7 72	19 12	13 26	24 66	5 33	9 91
Trabuco Water Co.	Capistrano	Mutual	70		340		64	404	1 51	300	100 00	100 00	1 00	100 00	6 00	2 00	None	None	None		2 00	8 00	2 00	8 00	1 32	5 30
Walnut Grove Mutual Water Co.	Monrovia	Mutual	100		261	260	260	781	2 34	781	50 00		1 00	50 00	3 00	None	0112	6 75	15 80		6 75	9 75	15 80	18 80	6 75	8 03
Whittier Extension Mutual Water Co.	North Whittier	Mutual	100	2,000				2,000	1 50	2,500	100 00		1 00	100 00	6 00	0 50	0250	15 00	22 50		15 50	21 50	23 00	29 00	15 33	19 33
Yorba Linda Water Co.	Yorba Linda	Mutual	100	2,500				2,500	1 08	2,768	100 00		1 00	100 00	6 00	13 40	None	None	None		13 40	19 40	13 40	19 40	12 41	17 96
Yucaipa Water Co. No. 1	Yucaipa	Mutual	25		2,051			2,051	0 53	3,500	100 00	100 00	1 00	100 00	6 00	3 00	0083	4 98	2 64		7 98	13 98	5 64	11 64	10 63	21 98
Appleton Land, Water and Power Co.	Hesperia	Public utility	0		60	110		200	0 80								0150	9 00	7 20			9 00		7 20		9 00
Beaumont Land and Water Co.	Beaumont	Public utility	27		1,065			1,065	0 33								0300	18 00	6 00			12 00		6 00		18 00
Bell Water Co.	Bell	Public utility	100				100	100	1 30								0125	7 50	9 75			7 50		9 75		7 50
California-Michigan Land and Water Co.	Lamanda Park	Public utility	100					700	1 00								0344	20 62	20 62			20 62		20 62		20 62
Citizens Water Co. of San Jacinto	San Jacinto	Public utility	29		1,800	700		2,500	1 00								0062	3 75	3 75			3 75		3 75		3 75
Cuyamaca Water Co.	San Diego	Public utility	5		4 500		1,000	5,500	1 00								0181	10 89	10 89			10 89		10 89		10 89
East Gardena Water Co.	Gardena	Public utility	100		50		430	480	1 73								0125	7 50	12 98			7 50		12 98		7 50
Haines Canyon Water Co.	Tujunga	Public utility	0	200	100		250	550	0 61								0220	13 20	8 05			13 20		8 05		13 20
Lake Hemet Water Co.	Hemet	Public utility	0	600	5,000			5,600	1 10								0076	4 56	5 02			4 56		5 02		4 56
Palmdale Water Co.	Palmdale	Public utility	0		400	125		525	0 75								0100	6 00	4 50			6 00		4 50		6 00
San Gabriel Valley Water Co.	San Gabriel	Public utility	100					700	1 00								0363	21 78	21 78			21 78		21 78		21 78
Santa Clara Water and Irrigation Co.	Saticoy	Public utility	0	303	574	213	5,058	6,148	1 25								0083	4 98	6 22			4 98		6 22		4 98
Southern California Edison Co.	Ventura	Public utility	0	300	550		2,150	3,000	2 78								0104	6 24	17 35			6 24		17 35		6 21
Sweetwater Water Co.	National City	Public utility	0	3,000		600	600	4,200	0 95								0145	8 71	8 27			8 71		8 27		8 71
Tujunga Water and Power Co.	Los Angeles	Public utility	0	250	250	250	250	1,000	1 00								0150	9 00	9 00			9 00		9 00		9 00

decided preference to the system that is operated cheaply and that the value, although influenced by, is not entirely dependent upon first cost. It is unnecessary to say that no one would undertake to develop water at an estimated cost exceeding its established value. In a few cases water stock has, through accidental or unforseen circumstances, depreciated below its cost; such as in the case of a city that grew out over and extended its domestic water service to territory served by an irrigation company with little demand for the irrigation rights because the surrounding country was already irrigated.

In California a water company may under its by-laws legally make the water it controls appurtenant to the lands irrigated; and where this provision of the law, sustained by the highest court, is exercised to the full extent, the water can not be sold separately from the land, and consequently does not in a natural way acquire an independent market value that is outwardly apparent, although such value exists under cover of the prices of the land. Some companies make the water appurtenant only to the entire tract to be irrigated by the system and to contiguous lands, and allow transfers of water between landowners within these bounds so that the user may invest only in so many share as he needs for the crop being grown.

A third class of companies puts no restrictions on the transfer of stock and safeguards its locality by prohibiting the extension of its service to new territory unless approved by its directors. Under the last two classes of companies it is easy to determine the value put on the water. The water rights are worth $100 to $400 per acre and they represent one-eight to one-fifth miner's inch, a sufficient amount.

Not only do the fruit growers invest large amounts of capital in water systems, but they also pay heavy annual charges for the water they use or that their shares in mutual companies entitle them to use. The total cost of the water delivered by a company to a stockholder is the sum of two or three separate items. The first, although not always included, is a proper charge and is the interest on the market value of the capital stock; the second is the amount of any assessments on the capital stock; and the third is the amount paid for the quantity of water used at any toll or rate in force. If any part of the revenues of the company are applied to payments on the principal of bonds or loans, proper deduction must be made from the sum of the three items mentioned, for the reason that the payments on the principal belong to the capital and not to the operating account. Only the interest on indebtedness is charged to the annual cost of the water.

Although in California all stock is assessable, some companies do not assess the stock every year, but only when some substantial improvement is to be made to their property or when payments are to be made on bonds. They must charge for the water to meet the running expense. Others make no charges for the water and raise all revenues by assessments. Other mutual companies distinguish between their capital and operating accounts, as public service companies must do, under state regulation, and more consistently make the stock the basis of the revenues that affect the property and value of the stock and the amount of water used, the basis of the revenue to meet the cost of delivering water.

Of the three items that make the total cost of water, the first and second are fixed charges because they relate to the share of stock and

The follo
California"
C. E. Tait,
which appe
Departmen
California (
taken from
Mr. Tait.
the end of
1920 by F. I
and C. E. T

COST O

In no par
become bett
California.
water or it
pany.

The capit
delivery to
reason the
title to wate
from wells.
miner's inch
combination
is worth $10
southern Ca
second, and
(1/40) part
of making t
are the suffic
the water ri
irrigation.
California ex

The posit
problems of
were known
more than a
that the pro
cost of the
here the proj
it is certain
suggested th
that constru
exceeds the o
of which mu
not appreci
due to wate
of the older

decided preference to the system that is operated cheaply and that the value, although influenced by, is not entirely dependent upon first cost. It is unnecessary to say that no one would undertake to develop water at an estimated cost exceeding its established value. In a few cases water stock has, through accidental or unforseen circumstances, depreciated below its cost; such as in the case of a city that grew out over and extended its domestic water service to territory served by an irrigation company with little demand for the irrigation rights because the surrounding country was already irrigated.

In California a water company may under its by-laws legally make the water it controls appurtenant to the lands irrigated; and where this provision of the law, sustained by the highest court, is exercised to the full extent, the water can not be sold separately from the land, and consequently does not in a natural way acquire an independent market value that is outwardly apparent, although such value exists under cover of the prices of the land. Some companies make the water appurtenant only to the entire tract to be irrigated by the system and to contiguous lands, and allow transfers of water between landowners within these bounds so that the user may invest only in so many share as he needs for the crop being grown.

A third class of companies puts no restrictions on the transfer of stock and safeguards its locality by prohibiting the extension of its service to new territory unless approved by its directors. Under the last two classes of companies it is easy to determine the value put on the water. The water rights are worth $100 to $400 per acre and they represent one-eight to one-fifth miner's inch, a sufficient amount.

Not only do the fruit growers invest large amounts of capital in water systems, but they also pay heavy annual charges for the water they use or that their shares in mutual companies entitle them to use. The total cost of the water delivered by a company to a stockholder is the sum of two or three separate items. The first, although not always included, is a proper charge and is the interest on the market value of the capital stock; the second is the amount of any assessments on the capital stock; and the third is the amount paid for the quantity of water used at any toll or rate in force. If any part of the revenues of the company are applied to payments on the principal of bonds or loans, proper deduction must be made from the sum of the three items mentioned, for the reason that the payments on the principal belong to the capital and not to the operating account. Only the interest on indebtedness is charged to the annual cost of the water.

Although in California all stock is assessable, some companies do not assess the stock every year, but only when some substantial improvement is to be made to their property or when payments are to be made on bonds. They must charge for the water to meet the running expense. Others make no charges for the water and raise all revenues by assessments. Other mutual companies distinguish between their capital and operating accounts, as public service companies must do, under state regulation, and more consistently make the stock the basis of the revenues that affect the property and value of the stock and the amount of water used, the basis of the revenue to meet the cost of delivering water.

Of the three items that make the total cost of water, the first and second are fixed charges because they relate to the share of stock and

must be paid whether any water is used or not, but the third varies according to the amount of water used by the stockholders. This together with the fact that the quantity of water used per acre is not uniform makes it a complex matter to fairly compare the cost of water under different companies. To compare the cost "per acre" is unsatisfactory where the duty varies, and to compare it "per acre-foot" (obtained by dividing the cost per acre by the duty of water in acre-feet) is objectionable where fixed and variable charges are added to obtain a total cost. In some respects the truth is more nearly approximated by stating the cost in terms of the "first acre-foot;" that is, assuming that all fixed charges as well as the price of that amount of water are applied against the first acre-foot.

A tabulation entitled "Cost of Water under Southern California Irrigation Companies"* has been prepared from cost data collected for the year 1918. It includes about 100 mutual water companies and 15 public utilities water companies.

On account of the complications that would arise from the many variable conditions influencing the cost of water, it has not been possible to classify companies and summarize and compare costs according to source of water or crops irrigated, or other plan, but the table prepared gives for each system the approximate proportions of the water pumped and obtained by gravity, the area of each crop irrigated, and the duty of water as well as all of the basic figures relating to shares of stock, assessments, and water rates from which the fiscal costs have been calculated, so the reader may draw his own conclusion as desired. For the purpose of this review the following brief summary is submitted.

By far the greater part of the area irrigated under the companies included in the tabulation, exclusive of the Colorado River valleys, is growing oranges and lemons. The other crops include deciduous fruits, walnuts, alfalfa and truck. Large areas of lima beans and sugar beets are grown along the southern California coast, but they are only in part irrigated.

The duty of water, excepting a few unrepresentative extremes due to water shortage, ranges from .68 acre-foot under the Garvey Water Company, irrigating deciduous fruits at San Gabriel, to 4.00 acre-feet under the Palo Verde Mutual Water Company irrigating alfalfa and cotton through the long hot and dry season of the desert climate on Colorado River. Generally the duty of water for citrus fruits ranges from one to two acre-feet, the lower amounts being for pumped and the higher for gravity water. The cost of the pumped water is greater than of the gravity water and the results show that the cost and not the requirement is the greatest influence on the duty of water.

The cheapest water is found under the old unlined ditches on the San Gabriel River, some of which were constructed by the Spanish. The companies are loosely organized and are capitalized as low as $10 per acre, although this can not represent the true present value of the water. In the absence of proper basis for interest charges the main expense under them consists of fees paid to the zanjeros and amounts to less than $3 per acre, or $1.50 per acre-foot under a duty of water of about two acre-feet. Under the representative companies about $6 per acre and $3 per acre-foot may be taken as minimum cost. These are found under some

*This table is similar to the one prepared for 1922, which has already been explained in detail under mutual water companies in the main report.

of the smaller gravity systems where the water rights are conservatively valued.

The highest costs are found under several systems near the foothills of the San Gabriel Mountains, where all the water is pumped from wells under lifts of over 400 feet. Under one of these the duty of water is 1.81 acre-feet and the cost of water per acre $51.87, of which amount only $3 is interest on the water-right valuation. Under another the duty is 1.41 acre-feet and the cost of water per acre $40.39, of which amount $5.76 is interest. Under this system the par value of the stock per acre is $128, but owing to the expensive operation the value has depreciated to $96 per acre. These are extremes, but under many of the older, larger and most representative water companies of the orchard communities the annual cost of water to the user reaches $30 per acre. Under companies of this class the rights are usually valued highly and often about one-half the total cost is interest.

The following data relating to a representative system is given as an example. This company irrigated 17,000 acres of which 10,000 acres is in citrus orchard. Most of the water is obtained by gravity. The stock is appurtenant to the land and can be sold by the company only. The shares, of which there is one for each acre, have a par value of only $5 each. After the first year of its life the company fixed the price of its shares by adding to the par value all assessments to date, together with simple interest on these. When this information was obtained the price had in this manner advanced to $117 per acre, which amount in this case is the basis of the interest charge in the cost of the water. The interest at 6 per cent is therefore $7.02, which is the first item in the cost. The assessment was $1.65 per acre, but of this amount 86 cents was to retire the principal of indebtedness, leaving only 79 cents as the second item in the cost. The water is delivered at rates which are equivalent to $1.68 per acre-foot, and the duty of water is 1.85 acre-feet, which gives $3.11 as the third item in the cost. Therefore, the cost of the water per acre under the average duty for this system is $10.92, and the cost per acre-foot, $5.91. If, however, the stockholder used only one acre-foot, its cost would be $9.49.

The average cost of water under the public service companies is less than the average under the mutual companies. This must not be taken as a comparison of the merits of the two classes of enterprises. The reason is that the public companies are nearly all of early origin and have gravity water to sell, while so many of the mutual companies, beginning later, can obtain water only by pumping. About 450 incorporated water companies are operating irrigation plants in southern California, and of these less than 40 are selling water for profit. The popularity of the mutual company in this region seems to be due to two main reasons: Nearly all of the valley lands were in Spanish grants and were never owned by the government; this prompted the acquisition by promoters of large tracts for subdivision and sale, together with water for irrigation; and the best way to transfer the water plants to the settlers was through the organization of mutual companies. The other reason for the preference for mutual water companies over other forms of irrigation organizations, is that no other form places the control so exclusively in the actual water users, which, like the cooperative marketing of fruit, has appealed to the characteristic independence of the fruit growers, as a class.

The cost of water under individually owned pumping plants, of which there are hundreds in the orchard districts, is not far different from that under the companies, as the same elements of cost exist, although they may be under different names. A question often asked, is: "How high can water be pumped economically?" Considering this only for the irrigation of citrus fruits, it may be stated that numerous plants are lifting water 400 feet, and over, where the territory irrigated is in a prosperous condition. Under two systems irrigating lemons, water is lifted 700 to 850 feet for small portions only of the lands served. The cost of water, although high as compared to many other regions, is a small percentage of the total cost of production of citrus fruits. If the cost of production be $150 per acre and the cost of water $20, the latter may be doubled without materially endangering the profits from a well-managed orchard.

o

37101 4-25 750